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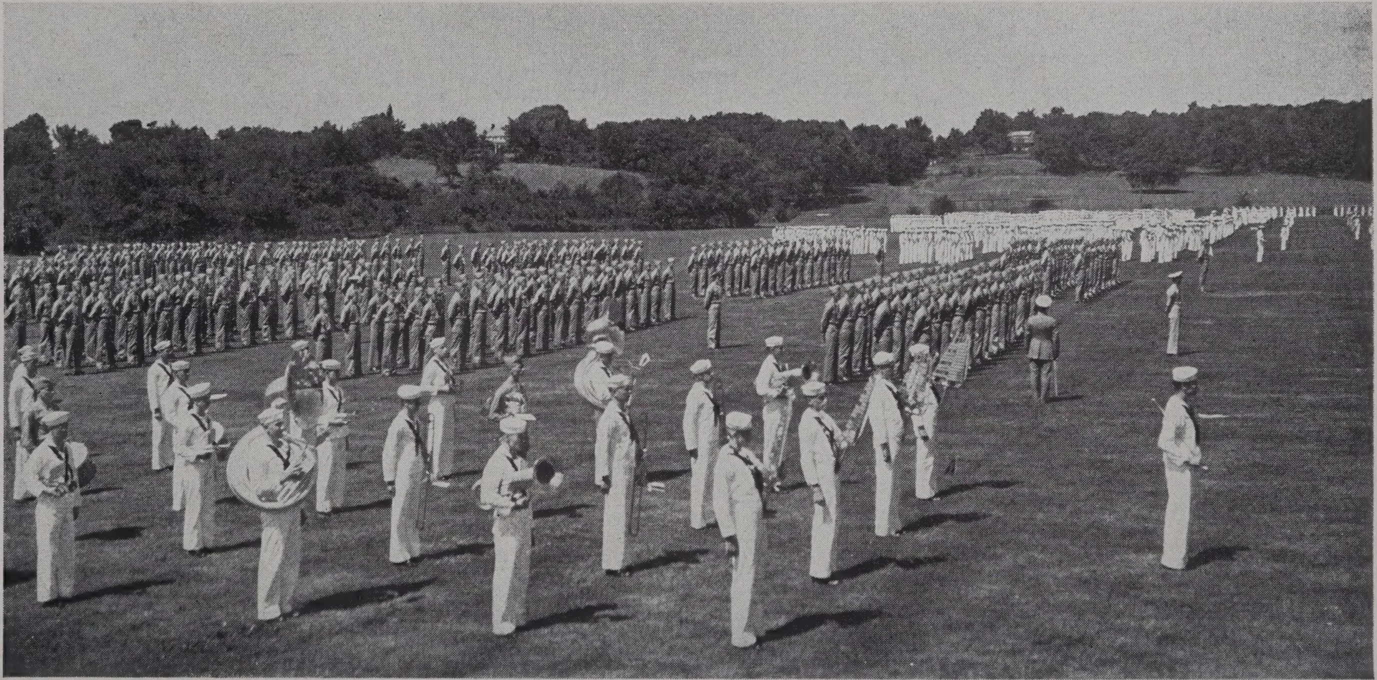
A Record of a University in the War Years



A Review on Intramural Field. The Navy came to Purdue in force, with both marines and sailors.

1941-1945

A Record of a University in the War Years

Edited by H. B. Knoll

THE ARCHIVES OF PURDUE
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INTRODUCTION

This volume tries to present the meaning to the state and to the nation of the record of Purdue University during World War II. It opens with an interpretation by Dr. Louis Martin Sears, Professor of History, of the historical developments leading to the war and of Purdue's contribution. Following chapters deal with the teaching and training conducted on and off the campus, some of the war research done, the work by the men and women in agriculture, and the activities of staff members who left the campus for military and civilian service. An attempt has been made to show how alumni and former students served their country, but this contribution of trained men and women to civilian and military activities was so vast that its extent could only be suggested, not specified.

This volume could be impressive in size, filled with names, dates, and multitudinous details. It was believed, however, that a small volume could be prepared to serve as a general record. Selection has been extremely difficult, and it has not been possible to obtain full coverage. For agriculture alone several hundred pages could be filled, and the same is true of other divisions. Condensation has resulted, it is hoped, in a volume that has some qualities of readability and is representative of the war service of the University and its people.

In a companion publication, 1941-1945, *The Roll of Honor of Purdue University*, appear the names with brief records of the more than five hundred men of Purdue who lost their lives in the military services, making the eternal contribution beside which all others rank only as fleeting events.

Throughout the war years the University followed a policy determined on June 8, 1940, when the Board of Trustees directed that all possible steps be taken to enable the University most effectively to contribute to the program of national defense. Thus, slightly more than a year and a half before Pearl Harbor, the University began to ready itself for eventualities. Among the first outward signs of the shape of things to come was the

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establishment of the Defense Training Office for the administration of training programs to provide workers for defense industry. Another was the strengthening of the flight-training programs at the Purdue Airport. In the fall of 1940 at the opening convocation, the theme expressed was that of fitness—fitness to face the bewildering uncertainties of a troubled world. Mr. David Ross described the times as the most trying of his nineteen years as a trustee.

Evidences of approaching war multiplied. Speakers came to the campus to present their views of the world situation. In May, 1941, the Navy began its selection of the men for the first squadron of the Flying Boilermakers, Naval Aviation Cadets to be taken through training as a group. In the following summer, from behind the Chemical and Metallurgical Engineering Building came the sound of small but sharp explosions set off by trainees in a course in the chemistry of powder and explosives. Members of the Reserve Officers Training Corps in the summer of 1941 participated in full-fledged war games in Kentucky. In September, after Selective Service had been in operation for almost a year, registrations for the new semester dropped slightly from those of the preceding year. The *Exponent*, in answer to a request for support from an isolationist organization, vigorously proclaimed that appeasement had no place at Purdue. Students were torn between their desire to enlist or seek employment until the crisis resolved itself and the appeals of authorities that they make themselves more valuable to their country by continuing their education.

When the blow fell on December 7, 1941, Purdue was prepared and already at work. President Elliott rallied the student body with a message in the *Exponent:*

> Now is the time to furnish proof of our unity and loyalty. Until it is known just what your new duties are to be, your business is to tend strictly to your business as students. This means chins up, heads clear, and firm brakes upon tempers and tongues. Youth such as you are going to be needed by the country as never before. . .

The University could then undertake its war program in earnest, knowing what its powers were and how they should be directed. The demand was for more trained men and women, more food, more scientific knowledge—more of all the big and the little things by which a peaceful democracy transformed itself into a nation of military might. This demand was one for which the University was prepared. Since 1869 it had grown as an integrated organization, representative of American democracy and devoted to the preparation of men and women to face the problems of the world, to the discovery of new knowledge, and to the general welfare of the nation.

The record shows an amazingly diverse achievement, for Purdue within the past three decades, reaching for the goal of greater and greater usefulness, has become an amazingly diverse institution. In this respect Purdue has marched with the cavalcade of other American institutions of higher learning and has come to represent the many sides of our many-sided civilization. This has brought a spreading of interests, an acceptance of the idea that a university must be much more than a scholar's refuge. Consequently, Purdue could and did support the war effort on many levels of activity.

The University helped in the training of men and women for the Armed Forces—soldiers, sailors, marines, and members of the WAC and the SPARS.

The University trained inspectors for ordnance plants, workers for Indiana farms, auxiliary firemen for civil defense, young women for radio and aeroplane industries, graduate students in several of the sciences, psychologists for personnel work, and policemen for industrial protection.

For Indiana industry the University's War Training Office ran the programs in which approximately 60,000 workers received training at the college level in the fields of engineering, science, and management.

At the same time the University accelerated its four-year curriculum and, with good success considering the times, intensified its education and training of the engineers, physicists, chemists, home economists, pharmacists, and agriculturists so greatly in demand, both as civilians and as members of the Armed Forces, in the fighting of a technical war.

In another contribution—research—the University expanded existing facilities, accepted all the problems that its staff could handle, and so created vital knowledge, for industry and the services, which gave substantial support to war production and the building of war weapons. This research, like the training and educational programs, demonstrated how diverse the University has become.

Research was conducted, to cite a few contrasting examples, on soy beans and high-temperature steam, on antimalarials and electronics, on industrial vision and atomic energy, on the protection of war plants and the building of airports, on dried eggs and automatic weapons, and on high-altitude flying and components of radar.

This research was conducted for commercial interests, the War Production Board, the Ordnance Department, the Navy, the Office of Scientific Research and Development, the Army Air Corps, the Civil Aeronautics Administration, the Quartermaster Corps, and other agencies.

These were the principal and distinctive contributions of the University—teaching, war training, and research. Purdue had its place in the scheme of things, and this place it maintained and strengthened. The University could and did work hard, like men and women in industry and on the farms, and it did have the facilities with which to accomplish a great deal. As a primarily scientific and technological institution, it was singularly fitted for the tasks of a technical and total war. Its support was sometimes dramatic, sometimes routine, at times direct, at other times indirect. That support it gave willingly and in full measure.

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Chapter I

PURDUE UNIVERSITY AND WORLD WAR II

PURDUE UNIVERSITY IN DECEMBER, 1941, WAS AN outgrowth of Nineteenth Century peace confronted with responsibility toward a Twentieth Century war. Here indeed was a major problem of adaptation, with issues carrying to the ultimate meaning of education and to the roots of social motivation. With the continuity of society itself at stake, questions that in more stable times might seem academic assume a terrifying urgency. Is education properly a resultant or a cause? Does society seek its own perpetuation? Or should education endeavor to remold society? Specifically, should a state-supported school reflect the ideology of the state? Or should it strive for goals beyond existing political, economic, and social concepts? Fundamental as such speculations are, they pale before the issue of survival. The state in peril summons all of its resources, educational not the least, to the national defense. Facing the threat of war, the educational resources of the nation meet their major test. In a war of worlds, Purdue University, like all her sisters, is swept into the maelstrom of events. Her very utmost is no more than duty.

If one would comprehend the relation of the University to so vast an emergency, a glance at times past is in order, though the point of departure is of necessity a matter for somewhat arbitrary choice. Remoter origins might tempt the inquirer, but for the present we may select a point approximately a quarter century before the actual opening of Purdue. Rather than the Morrill Act of 1862, which laid the legal foundations of all the land-grant colleges, Purdue included, we may contemplate the national scene in 1850, when the country faced the choice of immediate secession or its postponement for another decade, an issue fraught with tremendous consequences for the future University, the nation, and the world. For on this postponement hung, strangely enough, the issues of victory or defeat in World War II.

Indeed, few sequences in human affairs offer more alluring possibilities to the seeker after truth than the manner in which the Compromise of 1850 contributed toward the solving of future problems. What could be more unexpected, for example, than the part played by Henry Clay and Daniel Webster and Abraham Lincoln in the winning of World War II? Yet a moment's glance at the evidence leaves no room to doubt the importance of their contribution. The Compromise of 1850, largely the work of Clay, but supported manfully by Webster in his Seventh of March Speech, preserved the Union in 1850. Had secession been voted at that time, as it so nearly was voted, Union victory, so dearly bought in 1865, could not have been achieved. At least, historic probability points strongly in that direction. The decade following the great compromise witnessed an important growth of Northern power and population. A large increase of immigration to the Northern States and the construction of added railway mileage running east and west so changed the ratio between the sections that, when secession finally came, Lincoln and the forces under his command were able to preserve the Union, one and indivisible, with at least a promise of liberty and justice for all. In the formula of Lincoln, the nation could not endure half free and half slave. It must ultimately be all slave or all free. By assuring victory for freedom Lincoln foreshadowed a similar victory for all mankind when the issue was enlarged to a world scope. For the major issue of the Twentieth Century was but an enlargement of that of Lincoln's Day. The world could not endure half free and half slave. It must either be all slave or all free. In this decision the United States would certainly take part.

When in two gigantic wars, Kaiser Wilhelm II and Adolf Hitler launched their attack upon the forces of freedom which had been gathering momentum through all the centuries since the voyages of Columbus, they precipitated the most dangerous counter-revolution in the experience of our race, wherein every ounce of energy that free men could expend was requisitioned to the survival of a free world menaced by a barbarism indescribable. The issue was long in doubt, and a favorable outcome was assured only when the resources of the *United* States came fully into play. Hitler's gamble, the greatest of all time, was by no means the uncalculated frenzy of an idiot. It was backed by data carefully assessed. What it failed to estimate was the time element provided by Britain after the Dunkirk evacuation, and the improvement of that reprieve by the greatest industrial and military power the world had ever known to launch for freedom a force utterly unprecedented.

It is here, of course, that the part of Lincoln and his predecessors in the winning of the World Wars of the Twentieth Century becomes apparent. Had secession been achieved, had two, or possibly even more than two, confederacies operated within the confines of present-day America—for secession carried within its own philosophy the premise of extension of centrifugal tendencies—it is historically inconceivable that the central governments at Washington and Richmond could have operated with the unanimity that the times required. Even with the best will in the world and with joint recognition of the sinister nature of the Nazi intrigue, unity of action would have been a political impossibility. Totality of power could not have been assembled and a Hitler victory would have followed. Yes, the men of 1850 and again of 1860 had indeed a share in the victories of 1945.

Some such backdrop as the preceding is of utility in weighing the contribution of Purdue to the issues of a day in which her members played a part so creditable. Purdue University, with its authorization in the Morrill Act of 1862 and with its actual functioning in the 1870's, was not designed as an instrumentality for waging war. On the contrary, it was completely integrated with the second major period of the country's existence as an independent nation. If America from 1789 to the promulgation of the Monroe Doctrine in 1823 was a weak nation whose interests could be served best by isolation and an unaggressive attitude in general, America from 1823 till the War with Spain was at her zenith of security. Protected from attack by two great oceans, with neighbors north and south by no means dangerous, and possessing an energetic population straining at the leash for the conquest of a continent, America had no apparent cause for fear save in the few years of her Civil War when foreign interference would have been an added menace.

Her chief educational interest accordingly, in so far as education reflected the material aspects of existence, lay in the founding of just such institutions as Purdue to be dedicated to research and teaching in the fields of agriculture, technology, pharmacy, home economics, and general science. Similar objectives marked the land-grant colleges in general, none, however, more so than Purdue. It was the circumstance that America was actually at war when the Morrill Act was passed that was responsible for attaching to these peacetime objectives the rider, as it were, that recipients of the Federal bounty must devote some attention to national security. The land-grant colleges, in other words, must maintain departments of military science; some require the taking of courses in military training for the first two years, and for the second two years give optional courses leading to reserve commissions in the Army of the United States.

Naturally enough, not all the institutions thus created have met with equal zeal the military requirements of their founding. But all have played some part in national preparedness; and Purdue by no means least, rather *primus inter pares,* has developed her specialty of field artillery to a point where not even the West Point Academy furnishes an equal quota of officers in this particular branch of military science.

But as was earlier remarked, the temper of the 1870's and for many years thereafter called for expansion in the arts of peace. Here the land-grant colleges made their characteristic mark and became an important factor in the country's progress. And here again Purdue, in friendly rivalry with her educational peers, achieved important goals.

In agriculture, for example, how men like Washington and Jefferson, pioneers a century before in scientific agriculture, would have rejoiced at the systematic evolution of rural life in the development of superior breeds of animals and plants, in the interrelation of horticulture, plant physiology and pathology and later forestry, and what comfort the prudent Washington might have derived from a reflection that the researches of the late Dr. Joseph Charles Arthur into the rusts of wheat are reputed to have saved for state and nation an equivalent of all that has been expended at Purdue. Dedicated to the arts of peace and to richer and more satisfying living, these developments in agriculture were of vital aid to war, when every soil resource was called upon for victory. In forestry, especially, enormous military drains on timber taxed to the utmost such progress as had been more latterly achieved. For forestry was a Twentieth Century development in Indiana.

When Purdue University was founded and for a generation afterward, Southern Indiana in frontier fashion was concerned mainly in clearing land and in hacking and burning away those magnificent stands of hardwood timber that marked the forests of the Lower Wabash as the richest in the world. What need for conservation where Nature was so bountiful? And why should the rich prairies of Central Indiana be concerned with forestry in what was something like a foreign land? It remained for the Twentieth Century, in Indiana as in the nation, to reckon with a vanishing resource, and to develop at Purdue as elsewhere a proper training in scientific forestry. This training came not a bit too soon; but it proved of highest military value and it gives promise of economic restoration and stabilization in large areas of Southern Indiana designed and set apart by Nature as a permanent forest. That man perceives this with increasing clearness and is manifesting a belated willingness to co-operate with Nature is due in no small measure to the Purdue Department of Forestry.

In agriculture, with its correlated interests, Purdue has been a beacon-light of knowledge, first gleaned through laboratory research, and then diffused throughout the state. Short courses for farmers, business sessions for canners and other interests ministering to farmers, extension lectures, and the labors of county agents who received their training at Purdue—all have extended Purdue influence widely. But most of all as a rallying point and focus for agricultural interests Purdue has been integrated with the very life of rural Indiana as a unifying agency alike in peace and war. Individual leadership in these fields of the peace as well as the war effort will be noted in succeeding chapters.

In engineering, the institution has been equally progressive. Separate schools of Civil, Mechanical, Electrical, and Chemical and Metallurgical Engineering have developed parallel with, and at the same time stimulated, industrial progress throughout Indiana and the nation, until Purdue University, while making no invidious claims as to the quality of her competing schools, can boast at any rate of supremacy in size. Public favor has attended now one, now another, among the several disciplines. Under Professor, later Dean, W. F. M. Goss, it was the School of Mechanical Engineering that, in the years between 1890 and 1907, won international recognition for its researches in the field of locomotive testing. Continued support from railway interests brought to Purdue more recently a most elaborate testing of automatic brakes and couplers. In the recent war, the sustained researches of Professor George A. Hawkins and his associates into previously unexplored aspects of gun-fire and ballistics—researches to be discussed more fully in later pages—have won current recognition for an ancient and honorable division of the University, ably headed by Professor Harry Leland Solberg, whose own contributions have been noteworthy in the field of high-temperature steam.

These preliminary remarks by a non-technical recorder can not do justice to the various schools of engineering. The historian needs must be content with a species of orientation wherein technology is related to its wider background. With no disparagement to the great present utility of mechanical engineering, so indispensable to the training of managers and workers for the nation's huge industrial plant, it may nevertheless be observed without offense that its primary development coincided with the age of steam, whereas the School of Electrical Engineering has flourished as a sequel to Thomas Alva Edison and the incandescent bulb of 1890.

The modern world alike in war and peace depends upon electricity not only for the simpler needs of light and power, but for those mysterious supplements which the layman dismisses with a word—television, electronics, radar—as undefinable to him as electricity itself is undefinable to the greatest master of electrical controls. At Purdue University the School devoted particular attention in the peace administration of its late head, Charles Francis Harding, to the development of television. Under Dressel Dewitt Ewing, currently its head, attention has been inevitably directed to the potentialities of electronics. As a unit of research and teaching, and at the same time with other branches of engineering a stimulus to graduate students who in their turn are moving back the frontiers of our knowledge, electrical engineering stands amazed before the boundless possibilities of an electronic age.

In an era that began with Hiroshima, Nagasaki, and the releasing of the atom, it is more than ever difficult to define the boundaries of chemistry and physics. The spectrum is their true analogy, for neither one begins or ends. Toward the discovery and the release of this appalling force the Departments of Chemistry and Physics made such important contributions that, in the words of President Emeritus Edward C. Elliott, a path was worn between Oak Ridge, Tennessee, and the campus at West Lafayette. Again departments that were created for promotion of the arts of peace in a more spacious and expanded living were converted overnight into agencies of war. Even now the story can be told but partially. What can be revealed will appear in later chapters. Suffice it here to note that Purdue was thus fulfilling her mission as envisioned in the warlike Sixties rather than the destiny foreshadowed in the peaceful Seventies of her actual foundation.

This transition from peaceful purpose to warlike action lent singular distinction to the administration of Dr. Edward C. Elliott, 1922-1945. Longest in the annals of Purdue, it spanned the interval between two wars and vigorously shared in the prosecution of the second. While the nation was experiencing the artificial prosperity of the Twenties, the dire distress of the Thirties, and the feverish activity of the early Forties, Purdue pushed forward steadily on its appointed mission. Some share in the prosperous days of Harding and Coolidge was to be anticipated. A kind dispensation brought strength during the administrations of Hoover and Roosevelt, for the pump-priming efforts of various alphabetical agencies brought rich largesse to selected beneficiaries. And Purdue was indebted to federal aid for a large extension of facilities, notably in an addition to the Memorial Union, in a major contribution to the Fieldhouse, and in the erection of residence halls and a magnificent Hall of Music.

On the academic side, the Elliott administration was signalized by establishment through the generosity of the late David E. Ross of the Purdue Research Foundation and by the creation of a Graduate School. In many ways complementary to each other, the Foundation, under the informed direction of Mr. G. Stanley Meikle, and the Graduate School, headed by Dean E. C. Young, provide assurance that Purdue will not be limited to a merely teaching function, inevitably sterile unless fortified by genuine research. On the contrary, teaching will be vitalized by fresh knowledge drawn from a nearby source, and the intellectual content even of undergraduate instruction will be given added stimulus.

In the evolution of an organism, component members cannot readily be isolated. A general well-being attests the proper balance of metabolism. Correspondingly these twin expressions of responsibility for genuinely higher education, the Graduate School and the Research Foundation, cannot be segregated artificially. One cannot doubt, however, their rich potentialities alike in peace and war, and one is well assured that they participated effectively in the Purdue contribution during World War II.

The personal element in this contribution by Purdue was, of course, the major factor in any such participation. It is just here, however, that the recorder speaks most hesitantly, for in even a catalogue of ships, there are sure to be omissions, and in a catalogue of personal accomplishments those omissions may be genuinely tragic. Safest, then, to mention but a few among the leaders and to bear in mind that their followers were loyal.

President Elliott, with Trustee approval, set an example of war participation by the faculty. For approximately a year he commuted between Lafayette and Washington, where he was Chief of the Division of Professional and

Technical Training of the War Man Power Commission, 1942-1943. Similarly Dean Andrey A. Potter, as Chairman of the Advisory Committee on Engineering, Science and Management Defense Training since 1940, was for many months in almost constant consultation in Washington, where his unrivalled acquaintance with engineering personnel throughout the United States was of utmost value in the assignment of fellow engineers to their most productive tasks. Possibly of even greater service to the country from a long-range point of view was Dean Potter's additional service as Executive Director of the National Patent Planning Commission since 1942, where he has been unremitting in his endeavor to fortify the patent system as an ultimate line of national defense, and to defend patent rights against the theories of doctrinaires.

The talents of Robert Bruce Stewart, Vice-President and Controller of the University, likewise were employed in most congenial assignments. Officially his titles were Special Adviser to the Director, Office of Scientific Research and Development, 1940-1942; Special Assistant, Bureau of Naval Personnel, 1942-1943; and Consultant to the Director, A. S. T. D., United States Army, 1942-1943. Dr. Stewart's more comprehensive assignment as Chairman, Army-Navy Joint Board for Uniform Contracts with College Training Units, 1943, was the outgrowth of services on the campus in arranging with the Navy Department terms of contract for the education and maintenance at Purdue of large groups of V-12 sailors and marines in training for commissions. The resulting agreement was so acceptable that the Department adopted an identical contract in all schools where similar groups were stationed, and at the same time commissioned Dr. Stewart to draw up these contracts under his authority as Assistant to the

Assistant Secretary of the Navy. This was in itself remarkable. Doubly so, however, was a similar relationship between Dr. Stewart and the War Department. Traditional rivalries between War and Navy did not blind the War Department to the advantages of Dr. Stewart's system. And the Purdue Controller added to his existing duties a liaison responsibility as Assistant to the Assistant Secretary of War.

No less essential to the war effort was the role of Vice-President Frank C. Hockema, on whom in the frequent and protracted absence of associates fell a tremendous burden of executive responsibility for keeping the Purdue machine at maximum efficiency. Of corresponding service to the local war effort was civilian supervision of the campus program for the armed services, ably guided by Associate Dean Willard A. Knapp, who won the trust and confidence of both enlisted men and officers.

Mention may here be made of brilliantly successful researches in radar components conducted by Dr. Karl Lark-Horovitz and associates in the Department of Physics and of those multiple investigations which in their totality produced the atomic bomb. Here the work of Dr. Henry B. Hass, Head of the Department of Chemistry, Dr. E. T. McBee, and a numerous assisting corps deserves especial recognition. Theirs is, however, only a portion of a magnificent coordination that unites the America of rugged individualism with the newer America of increased cooperation. For in more ways than one, atomic energy represents a dividing line between old and new in America and throughout the world. The individual inventor has not lacked his triumphs. But only the combined resources of a wealthy nation could have produced the atomic revolution which, now that it is here, points anew the road to heaven or to hell. Wisely used, the new energy beckons to a progress never dreamed before. Ignorantly or selfishly used in the traditional pattern of international anarchy, it points to utter ruin and the eclipse of Western civilization. Mankind, Purdue along with all the rest, is at the crossroads.

What its choice may be will be in part determined by the alumni. They in final analysis are at once the representatives and the determinants of their Alma Mater's policy, and in some not measurable degree the creators of American and even world opinion. Represented directly on the Board of Trustees; represented indirectly in all concerns of the University through their friendly contacts with faculty and administrative officers in learned societies of interest to both the University and its former students; influential through their continued interest in fraternities social or honorary; concerned in numerous instances as parents of the present students—not to mention those athletic enthusiasms that are universally their prerogative—the alumni are in many respects pacemakers to the University. That their example was a potent one in World War II is a self-evident fact. Eminent in civilian as well as in military life, the alumni have written a proud chapter in the Purdue record of service.

It is accordingly greatly to be hoped that alumni who are distinguished in technology and the sciences will share with civic leaders everywhere a recognition that the social scientist and the historian now as never before are entitled to their day in court. Engineers and farmers, pharmacists and home economists, scientists however noted, are so busily engaged in widening frontiers of knowledge in their respective fields that they may readily lose sight of that larger picture which is the special province of the statesman—of the statesman, moreover, who takes cognizance of what the social sciences can teach, and whose ideals are founded in the best traditions of his country. This non-technical world, remote from the contemplation of the technologist, is the world of the social scientist and the historian. Here Purdue, and the practical world of affairs of which Purdue is so characteristic an expression, may wisely ponder the eternal verities. *Cui bono?* as the Romans would have said, if we erect the proudest fabrics only to destroy them by an energy which, if guided properly, would give ordinary men a stature truly godlike. Dare one produce the bomb, then leave it to the judgment of children and barbarians? Engineers must needs fulfill their destiny. But their work is just so much destruction unless controlled by men whose vision is the general welfare.

Just how stimulating to such vision is a Purdue education? What is, in fact, Purdue's true place in education and in life? Integrated by the founders with the more practical aspects of affairs, separated as much by accident as design from the types of study pursued at Indiana University, committed to a program in which pure science is more or less subordinate to invention, can Purdue realize the ultimate in service? To answer that her students performed brilliantly in war, that her research staffs made distinguished contributions to the general effort, that numerous alumni held positions of leadership in peace which carried over into war, is not a final statement of the case. At a time when civilization actually totters, a new civic spirit is in order. And here one discovers that too many of the Purdue community are oblivious of world matters. Current events carry little meaning. In training for an honest living few realize the possibilities of leadership.

Awareness of what America has been, now is, and may even yet become, is not a salient feature of thinking at Purdue.

To convert that thinking to a more dynamic leadership, fresh stimuli would seem to be required. A larger emphasis on pure scientific theory would vitalize those practical affairs in which Purdue is chiefly interested. Of even greater value, a larger emphasis on social studies, notably in the field of political science and theory, might win Purdue adherents to a new philosophy of leadership, to a new perception of *noblesse oblige*, of the responsibility imposed upon a governing class to lead and not to follow.

Purdue in peace and war alike has met the expectations of the State. That those expectations are even now expanding is inherent in a living organism. Founded in one century to meet the needs of an expanding economy, consecrated in another century to the defense of a great heritage, Purdue, after the winning of two wars in which she played a valiant part, is now confronted with the greatest task of all. Along with all the world, she is confronted with the problem of political, yes, spiritual, control over those new forces that she herself in part unleashed. To achieve this mastery, Purdue, like all the world, must awaken to a new perception of life's meaning.

LOUIS MARTIN SEARS.

Chapter II

WARTIME TRAINING AND EDUCATION

The "Normal" Program

Purdue University recognized its primary responsibility as that of training young men and women for service to the nation, and early in the war began the adjustments that assured maximum use of its educational facilities. Ahead could be seen a multitude of obstacles in the path to be taken, and it is probable that few believed that enrollments could be maintained at the level to which they were held. But the policy was set that, insofar as possible, education would remain a going business and would run at a pace to match that of wartime America. Purdue had the conviction that the training it offered was the sort of training needed by a nation engaged in total war.

This was true in all schools. In engineering, pharmacy, home economics, agriculture, and science, the University continued to function as an educational institution.

Considerable success rewarded the University's efforts to meet its primary responsibility. To the last year of the war enrollments of students taking on-the-campus instruction remained high. This was accomplished because of the University's readiness to accept new assignments and because of the demand for the training that Purdue offered. Selective Service pulled hard on civilian men students and on occasion caused the Registrar's "Outlists" to be several pages long. From the fiscal year 1942-43 to the fiscal year 1943-44 the number of new undergraduate men students admitted declined from 2,700 to 1,236. But at the same time the University undertook the training of large groups of Army and Navy men and small groups of girls from industry who were enrolled as special students. An increasing number of students transferring to Purdue also helped to fill the classrooms and the laboratories.

A highly condensed overall picture of enrollments is shown in the table that follows, the figures including only those students whose records were kept by the Registrar. The numbers include regular civilian students, men in the Army and Navy Specialized Training Programs, young women trained for Curtiss-Wright and the Radio Corporation of America, and students in the Agricultural Winter School. They do not include members of other important groups trained by the University, some of these being the Army and Navy fliers trained at the Airport, the technicians trained through the ESMWT program, and the men in the Electricians' Mates School of the Navy, none of whom were enrolled as special or regular students.

	School Year					
	1939-1940	1940-1941	1941-1942	1942-1943	1943-1944	1944-1945
Total Resident Students..	8373	8101	7556	8161	9002	6020
Total Freshmen.........	2253	2057	2054	2708	1548	1480
Bachelor's Degrees Granted	1153	1073	1141	1210	925	580
Advanced Degrees Granted	178	208	159	108	120	90
Women Resident Students Enrolled	1683	1710	1620	1645	1806	2114

The high in Total Resident Students at 9002 in 1943-44 reflected the presence of men in the Army and Navy programs. The subsequent drop came from withdrawal of the Army men and the workings of Selective Service.

The high of Total Freshmen at 2708 in 1942-43 showed the effect of the accelerated educational program.

The figures for Bachelor's and Advanced Degrees Granted show how, increasingly throughout the war, young men found it impossible to complete their training.

And the figures for Women Resident Students Enrolled indicate that for the first time in Purdue's history, the number of women came close to equaling the number of men civilian students.

The switch of conversion from peace to war was thrown on December 26, 1941, when the Executive Committee decided that, for the duration, the University would operate on an accelerated teaching schedule of three sixteen-week terms a year instead of two semesters of eighteen weeks and a summer session of nine weeks, as had been the custom since the close of World War I. It was further decided to abolish final examinations and to cut vacations to a minimum. Postcards were sent to the students, who were then home for the Christmas season, summoning them to return immediately after the first of January.

The new schedule permitted students in continuous attendance to earn their bachelor's degree in two years and eight months rather than in the four years of normal times.

Other steps taken to insure maximum use of the University's educational facilities concerned the admission of students who normally would have been required to spend further time in high school. First it was agreed that the Director of Admissions could admit, by qualifying tests, students who did not meet the prescribed entrance requirements. This action made it possible to avoid splitting hairs on numerical rank in the graduating class or on small deficiencies in subjects or credits. Then, in November,

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1942, the faculty approved the admission of superior students who had not been graduated from high school. For this second group the Division of Educational Reference administered a battery of tests which included some for which the University had standardized results gained over a period of years, and one special test vital to the success of the plan: a test of social maturity. Far from lowering standards of admission, the new practices actually afforded an opportunity to exercise a more accurate selection of new students on the basis of their individual capacities.

In the summer of 1943 the setting up of the Army Specialized Training Program and the Navy College Training Program put the University's adaptability to a tester. The Army arranged for terms of twelve weeks, which plainly could not be synchronized with the civilian term of sixteen weeks. The Navy specified a term of sixteen weeks, but the first Navy term opened when a civilian term was about half completed. In order to avoid running three schedules simultaneously, the University conducted in the fall what was called a Semi-Term, in which civilian students carried but half a load—that is, they took half as many courses as usual, but a three-hour course met six days a week instead of the customary three. This improvization allowed the civilian students to finish their courses and then begin a new term at the same time that the new Navy term began.

Registration dates under the new calendar, however, did not coincide with the ends of periods of instruction in most secondary schools, and it was obviously wise to admit high-school graduates without having them wait several weeks for a new term to begin. To meet this situation, the faculty approved the war-named Intrasessions, eight-week periods of instruction in which students, as in the

Semi-Term, carried a reduced load at an increased speed until their schedules could be synchronized with those of the regular program. As a consequence, there were six times during the calendar year when new students could register and a corresponding number when students were graduated. From June to September had been the pleasant days of vacation, or of work, while high-school graduates waited for the registration in the fall. Now many of them, using the opportunity of the intrasessions, came immediately to the University for such training as they could receive before induction into the Armed Forces.

These major changes in the academic calendar necessitated an amount of unspectacular ground work that required full co-operation of all the officers and members of the staff. "Only from the inside," President Elliott stated after two and a half years of war, "is it possible to appreciate the heavy drafts upon physical strength, professional skill, and patriotic spirit necessary to keep the University in productive activity on an all-year schedule. Yet this has been done, and in ways yielding more than the customary satisfactions."

Heavier teaching loads, assignments to new courses, drastic fluctuations in schedules, and some participation in research—these were the lot of the instructional staff. Not much was exciting about this contribution. It was mostly the doing of a normal job made more exacting, like the supervision of a factory production line asked to increase its output. The teacher of physics, mathematics, thermodynamics, structures, or pharmacy won no headlines or Army-Navy E Awards for greater production of trained students, but without his devotion to the successful completion of his tasks the University could not have attained its record in wartime education.

Emphasis on the technical training of immediate use to industry and the Armed Forces caused some shifting of staff members from one division to another. Staff members from the School of Agriculture, for example, taught in such strange fields as mathematics and engineering—and demonstrated their capabilities by teaching successfully. When it became apparent that Army and Navy men would flood the courses in mathematics and physics, in which student numbers were already high, refresher courses for staff members of other departments were given through the ESMWT program, seventeen persons receiving certificates in each subject. It was not impossible to hire new teachers, but it was not easy; and industry wanted badly the services of experts from the technical schools and was granted those services when an allocation could be made. But, in one way or another, a staff sufficient to handle the load was kept on the campus.

Another problem for the instructional staff possibly should be mentioned in passing. Students have always wanted good grades for the sake of eligibility for sorority or fraternity membership, scholarships, continuance in school, or athletic participation; and instructors, whatever the public may think, have lost weight and spent sleepless nights over decisions that meant the difference between temporary heartbreak and temporary jubilation. The servicemen on the campus, particularly the veterans, sharpened this problem till it hurt, at times putting the instructor in the position of a draft-board chairman. "If I can't earn a 4 in this course," one veteran remarked, "I'll be going back to the fleet. I've already been on one ship that had to be beached, and maybe that's enough."

Gradually the arrival of servicemen and other groups created a housing problem. Civilians living in the men's residence halls, with a normal capacity of 1,050, were first required to double up and later required to move out altogether. The Committee on Student Housing undertook the task of finding rooms for civilian students in private homes in West Lafayette and Lafayette, and a member of the sociology department, engaged to make a survey of all rooms rented to University men and women, persuaded many people to rent rooms who had not done so before. When the Army and Navy programs began operation in full force, new bunks and cots were put up in residence halls, and 21 of the 35 fraternity houses in the community were rented for soldiers and sailors. Signs on the fraternity grounds pointed out that the fraternity houses had become military or naval reservations.

Girls in the Women's Residence Halls not only lived two to a single room and three to a double room but also did some of their own housework. Crowding in their quarters was borne in good spirit and caused no slump in their scholarship average. The household chores were done because of the shortage of help which afflicted the whole country, few cooks and maids being for hire. The girls cooked, set and waited on tables, helped the maids, washed dishes, and cleaned. No wages were paid for these services, but the rates for room and board were not raised in spite of the increase in the cost of living.

The composition of the student body, of course, changed drastically. Purdue was accustomed to uniforms in peacetime because of its courses in military training, but not to uniforms in such numbers and variety as appeared on the campus after the wartime training programs were in operation. Between April 20, 1943, and June 25, 1944, to cite a specific period, 2,132 men were enrolled in the

Army Specialized Training Program, 200 in the Advanced Reserve Officers Training Corps, and 1,683 in the Navy College Training Program. In addition to these, were the hundreds of Electricians' Mates who each week-day morning marched from the good ship *Cary Hall* to their classrooms by the Mall.

As indicated previously, the number of women increased as the number of men civilians decreased, a circumstance that aroused much comment in the lighter columns of the *Exponent* as the famous ratio of men to women came closer and closer to unity. Purdue throughout its history had been definitely a man's university. Now a changing atmosphere prevailed. Not only were many classes predominantly feminine, but many of the positions usually held by men in student activities were, of necessity, filled by women and so successfully filled as to threaten male dominance thereafter. Further, women entered courses that had scarcely ever before enrolled a woman, invading the areas that men had thought their own special fields. The School of Chemical and Metallurgical Engineering, for example, had nine women enrolled in 1944-45. Previously this School had had difficulty finding employment for its women graduates, but the two who were graduated in 1945 accepted employment in strictly chemical engineering work, with promises of post-war employment on the same basis.

The University consistently recognized an obligation to retain as much of the normal campus life and of the normal activities of students as its war activities would allow. In the times of great stress and uncertainty when for many students the future could not be charted, it was believed that morale and diligent application to work could be promoted if the University created a stable environment. To this end, many of the features associated with University life were continued, including athletics, convocation, and the drama of the Purdue Playshop. Besides these regular features, wartime entertainments called "Victory Varieties" were held in the Hall of Music from time to time. These shows, primarily for the servicemen, brought to the campus different musical and vaudeville acts of a definitely lighter touch than the programs of the normal convocation series. Another show on the light side, "Hit the Deck," was successfully staged (with the help of women students) by men in the Navy program.

Student morale, nevertheless, at least became a subject for discussion, morale including regular attendance at classes, submittal of work on time, and general behavior. On the one hand civilian men students, whether 4F or not, felt submerged among the servicemen and were subjected to many other influences likely to have deleterious effects on their attitudes. On the other hand was the recognition that the training Purdue had to offer was useful both to industry and the Armed Forces; and many of the civilian young men were undoubtedly motivated by the urge to secure as large a stake in higher education as they could before they went to war, with the thought that they could secure further training after induction and return after the peace to win their degrees. But it is the purpose of this brief mention of morale only to show that an argument existed, not to settle the dispute. One interesting explanation was that staff members, after many months of almost continuous teaching and extra duties, were becoming irritable.

Whatever the state of morale, good morale was demonstrated in the workings of the Student War Council, an agency authorized on December 30, 1941, so that the "students of the University may be enabled to participate, actively and continuously, in the concerted efforts of the University to contribute to the National War Program." The Council had many functions and sponsored many wartime activities—the sale of Defense Stamps, University convocations, conservation, discussions of current national and international affairs by members of the Department of History, Economics, and Government, and the reduction of student expenses. In one of its campaigns the Council was active in the collection of about $1,185 for the Red Cross and in the collecting, cleaning, and shipping of nearly 2,000 books for Allied prisoners of war. For the work with the books, the Council enlisted the aid of other campus organizations. The books were collected from students by members of the Gimlet and Reamer Clubs; the cleaning was directed by the Activities Bureau; and the money necessary to ship the books to New York was given by students in the Women's Residence Halls.

For the civilian students who were graduated there was obviously no difficulty in finding employment. Workers of all kinds were hard to obtain, and persons with advanced training were in great demand. The Placement Service for Women reported a high percentage of the women graduates taking positions in teaching and in various business and technical fields, including dietetics, institution management, laboratory technology, personnel work, psychology, and occupational therapy.

The Office of Personnel of the Schools of Science and Engineering faced problems both simplified and complicated. The numbers seeking employment were reduced because of the many graduates who went directly into the Armed Forces, but at the same time industry increased its appeals for the men it so badly needed in war work. Industrial men almost literally besieged the office. A policy was inaugurated to persuade industry to interview young graduates even though they were to be inducted into the Armed Forces within a week or two of graduation, with a view to employing them after their return. In some cases, such graduates reported for work for periods as short as several days or a week, and then were placed on military leave by their new employers. Since the office could not begin to supply the demands, it concentrated its efforts on improving relationships between the University and industry so that after the war its services would be in good condition for efficient work. Services of the office were offered to men in the Army and Navy programs on the same basis as to students in civilian courses, and success beyond expectations was achieved in interesting companies in the post-war employment of servicemen.

During the early war years various branches of the Armed Forces moved entire recruiting units to Purdue for several days for the purpose of interviews, physical examinations, and the giving of the oath of office here on the campus. As a result of these methods, it is estimated that nearly fifty per cent of the civilian men graduates throughout the war were taken directly into the services and assigned to training that led to commissions.

The "normal" teaching program of the University, it may be said in summation, was conducted to the best of the University's ability under circumstances that required quick adaptation to change. It could not remain normal in the sense that students would come for four years with summer vacations between semesters and then be graduated into civilian life; but it was continued and it did give training to young men and women in fields in which their training was badly needed. Obstacles in the path chosen by the University were overcome so far as they could be.

The fact remains, nevertheless, that at Purdue and at other institutions higher education was to some extent a war casualty and must be considered as one of the nation's war losses. Despite the accelerated program and similar measures, the number of students permitted to continue their technical training, either undergraduate or graduate, was sharply reduced; and there are authorities with strong convictions that a mistake was made when highly promising young men were drafted into the military services from the technical and scientific schools. Whatever the reader's views on the subject, it is evident that there is now a shortage of the trained men and women needed to keep the nation in the front ranks of technical progress.

TRAINING FOR THE ARMED FORCES

The Reserve Officers' Training Corps. In peace years, all physically fit male students of the freshman and sophomore classes were required to take what was called the basic ROTC course. The first- and second-year advanced courses were composed of junior and senior volunteers who wished to continue their training and be commissioned in the Army Reserves. The Corps here at the University had been for some years the largest field artillery unit in the United States and for nearly a quarter of a century had consistently received a rating of "Excellent." To 1940, nearly one full sixth of the Field Artillery Reserve officers in the Army of the United States had been produced by Purdue University.

It goes without saying that the many thousands of men trained in the basic courses were a step ahead of untrained men and added materially to the manpower potential of the nation. During the 1930's when to be in a uniform meant being called, in some quarters, a warmonger, and when any industrialist whose factories might be used to produce war materiel was dubbed a "merchant of death," the University held to its policy by which two years of military training were required.

Of the Reserve Officers excerpts from the report of General Marshall to the Secretary of War, for the period from July 1, 1943, to June 30, 1945, tell a significant story:

> The depleted officer ranks of the Regular Army were filled by the reserve, the countless new staffs and organizations were mainly composed of reserve officers, the great training camps for men inducted through the Selective Service System drew in the beginning on the officer strength of the Reserve Corps. The Officer Candidate Schools from which our present Army acquired its vital small unit leadership were staffed by reserve officers. These officers were largely veterans of World War I and graduates of the Reserve Officers' Training Corps. . . .
>
> Though ROTC graduates composed 12 per cent of the war officers, its most important contribution was the immediate availability of its product. Just what we could have done in the first phases of our mobilization and training without these men, I do not know. I do know that our plans would have had to be greatly curtailed and the cessation of hostilities on the European front would have been delayed accordingly. . . .

During the war years the Reserve Officers' Training Corps at Purdue experienced many changes of fortune, with officer candidates being sent to training camps and then returned, with the increase to 556 of the quota fixed by the War Department, and with the establishment of an Ordnance Unit in the advanced course. Consistently, more men volunteered for the advanced courses than could be accepted. Finally, in March, 1944, upon the departure of the last of the advanced course students in response to calls from officer candidate schools, field artillery training was discontinued and the basic course in ROTC became branch immaterial. A cadet system was instituted in the basic course, with sophomores acting as cadet officers. In May, 1944, and again in June, 1945, at the annual ROTC Corps inspections, the Corps received its customary rating of "Excellent."

The Navy College Training Program. The Navy College Training Program, usually referred to as V-12, was designed to create a reservoir of trained officers from which to staff the units of the rapidly growing fleet. At Purdue it opened on July 5, 1943, with an enrollment of 1263 men, of whom about two thirds were sailors and one third marines. In successive terms enrollments were 1251, 1183, 1204, 841, 651, 521, 572, and 281. In all, about 2730 different men took training in the Navy program at Purdue, and about 400 were graduated with bachelor's degrees.

Shortly after V-J Day the Navy revised its program to provide for the establishment here on November 1, 1945, of the Naval Reserve Officers' Training Corps, which, as the name suggests, leads to the awarding of Reserve Commissions. Official action to meet this change was taken by the Board of Trustees, which authorized the granting of the degree of Bachelor of Naval Science and Tactics. To earn this degree, men will complete a four-year course that includes 24 semester hours of naval subjects taught by naval officers stationed at Purdue. They may then earn their regular academic degree by completing the course work to meet the requirements of the schools in which they have been enrolled.

The wartime Navy V-12 program was conducted in terms 16 weeks in length, and the University, by running the Semi-Term in the fall of 1943, was able to provide a single calendar for both civilian and Navy students. The Schools of Engineering adopted the Navy program of study in aeronautical, civil, electrical, and mechanical engineering for civilian students in these fields.

Near the end of each term qualifying examinations were given to all second-term basic and engineering trainees to determine which would be continued in the program. Those successful in the test were assigned to one of the engineering specialist curricula or to the deck or supply curricula. Trainees assigned to engineering specialist curricula were allowed to continue in school for a total of eight terms. The programs of study for the other trainees varied in length from four to six terms and led to line officer commissions. At the termination of their stay at Purdue the men were sent to midshipmen's schools, usually for three months, and were commissioned on successful completion of their work there.

When the Navy program opened, men were recruited from among college students. Purdue received trainees from many parts of the country—Illinois, Missouri, Washington, and elsewhere—but after the first half of the program almost all the new men were veterans from the fleet, many of whom had received high service awards. Now numbers of these men are returning to Purdue to complete their education under the G.I. Bill of Rights.

In some respects the Navy men were like university students in peacetime. They were quartered in the Cary Halls and different fraternities. They did not march to class like the Electricians' Mates and were allowed some options in the selection of courses. Administration was handled by University officials, and all the courses except those in naval science were taught by Purdue staff members. On encouragement from the Navy, the men participated in extracurricular activities, winning places and starring on the athletic teams, working on the *Exponent*, taking roles in the dramas staged by the Purdue Playshop, and in other ways joining in the activities of University life.

In most respects, however, the Navy required the men to lead a disciplined, military life. A Navy man on an athletic team was not permitted to make a game trip that would keep him away from the campus for more than 48 hours. When a class met to which a Navy man was assigned, he was required to be there and on time. Calisthenics in the morning, captain's inspection, watch duty, Saturday-afternoon reviews on Intramural Field, required study in quarters four evenings a week, care of rooms—these were some of the duties that allowed the Navy men little time in which to forget that they were here for a serious purpose.

The Army Specialized Training Program. At Purdue the Army Specialized Training Program (ASTP) was inaugurated on March 8, 1943, with the activation of the 1545th Service Unit. Headquarters were set up in one of the units of the Men's Residence Halls. The first contract called for the housing, messing, and training of 500 advanced engineering trainees. Later, provisions were made for the training of 125 in a course in personnel psychology and 750 in the basic course, in addition to the original 500. Though these numbers were never fully met, enrollments for four successive terms were 107, 922, 1348, and 1189, the latter two figures including a small number of reserves. With the exception of the reserves, the trainees were selected from young men already in the Army. Since the Army trainees were at Purdue during one of the busier periods, quarters had to be provided in the Agricultural Engineering Building as well as in the

Men's Residence Halls and different fraternity houses. On March 31, 1944, ASTP was discontinued and the trainees were sent to various Army camps and posts.

Further training for the Army was done, however, in the Army Specialized Training Reserve Program (ASTRP) for seventeen-year-old boys just out of high school. At Purdue this had been begun in November, 1943. Enrollment reached 213 by the next August, and this group remained for two terms, until the end of January, 1945, when ASTRP was discontinued at Purdue. The boys in this program received a pre-induction training and, as they reached the age of eighteen, were subject to Selective Service.

The men in ASTP varied greatly in quality and in amount of previous training. They were reported to be, on the average, somewhat superior to civilian students in peacetime, and some of them were highly endowed, particularly those in the course in personnel psychology. Instructors found them to be alert and, after Army life and training, more mature than civilian undergraduates. The men were also more difficult to handle, although subject to partial Army discipline. After training in the Army camps and amid conflicting rumors about their future, they found it difficult to sit quietly in classrooms.

In the three twelve-week terms of the basic course the Army men took English, mathematics, chemistry, physics, history, and geography. Those in the three advanced terms took engineering and the higher mathematics necessary for engineering. Course content was definitely stipulated by the Army.

The twelve-week Army terms corresponded with none of the terms which the University had scheduled for its civilian students or with the sixteen-week terms of the

Navy program. This was unfortunate in that, besides requiring many adjustments in the curriculum, it made the soldiers feel that they were not so much a part of the University as might have been desirable.

The Naval Training School for Electricians' Mates. June 16, 1942, saw the beginning of one of the University's most successful war training programs when a unit of the Men's Residence Halls was commissioned as a U. S. Naval Training School, Electrical. There were housed bluejackets who in an intensive four-months course were trained to be electricians' mates. The men arrived in groups, at first of 200, and later of 100. The normal complement of the program was 800 men. Before the close of the school on June 30, 1945, approximately 6,000 men had completed their training and been assigned to additional training in other schools or to active duty with the fleet. Reports sent back by the men indicated that their training here enabled them successfully to carry out subsequent assignments. Purdue was the last of the commissioned electricians' schools to close.

The number of teachers varied somewhat from one period to another, but, as of June 30, 1943, a staff equivalent to 48 fulltime instructors was employed to teach approximately 875 trainees. Maintaining an adequate staff in the face of competition from industry and loss of men to the Armed Forces was at least a minor triumph of administration. The University was responsible only for the teaching. Navy supervision was given by a Ship's Company, which through excellent co-operation earned a fair share of the credit for the efficiency with which the program was operated.

Laboratories for the school were equipped in the Michael Golden Shops and the Electrical Engineering and

Physics Buildings. The Navy furnished much specialized equipment for instruction, including searchlights, signaling equipment, switchboards, batteries, and lathes and shop equipment. Power companies made substantial donations of apparatus that otherwise would not have been available. Preparations of facilities and staff were begun six weeks before the arrival of the first group of sailors.

While here, the sailors studied mathematics and electrical theory and took work in the electrical laboratory, the wiring laboratory, and the tool laboratory. In addition, they took physical education and saw instructional movies. Each Saturday afternoon they stood captain's inspection and on Saturday evening and Sunday were given leave to "go ashore." Their schedule, after a revision in the program in December, 1942, required 44 hours a week besides eight hours of supervised study. Tutors for the supervised study in the beginning were staff men and undergraduates, these having been replaced later by Electricians' Mates. Trainees received a screening test on arrival, and those found inadequately prepared were given a special one-month course in mathematics, reading, outline making, and note taking before they began the regular sixteen-week course. Included in the "ship's company" were Waves assigned to duty as supply officers, yeomen, and pharmacists' mates.

The sailors were a cross-section of America, having come from every state in the union. Many were young, but a number were older, in their thirties, and had been settled in home and job. One company had 78 married men out of a total of 97. Upon completion of their course, more than half of the sailors trained at Purdue were assigned to advanced schools for additional training in such naval functions as convoy duty, mine warfare, and amphibious operations. In the closing months of the program, all graduates were assigned directly to the Fleet.

The School for WAC Personnel Administration. Purdue University was the site chosen by the War Department for its School for WAC Personnel Administration, which opened on April 17, 1945. Students were women officers assigned to duties involving the administration of WAC enlisted personnel—company officers, staff officers, inspectors, and recruiters. These were assigned from various Army commands in the United States and overseas and attended two-and-one-half-week classes in groups of approximately 90 each. Nine such classes, ending on October 12, 1945, were required to accommodate the 818 who attended. These women were of ranks ranging from second lieutenant through lieutenant colonel.

Many of the officers had for two or three years been responsible for the command and well-being of enlisted women at Army installations. The school was designed to enable them to share with other students the most successful personnel practices developed by their commands and to give them the latest information that might be of assistance with their jobs. Army organization and policies and the development of the Women's Army Corps were discussed. Emphasis was placed on principles of personnel management and adult psychology. Since demobilization plans were becoming of importance, information was furnished concerning demobilization processes and readjustment. In short, the school was planned to assist those who administered WAC personnel better to fulfill their responsibilities to the women and to the Army.

Training doctrine and curricula were directly under the War Department General Staff, Office of the Director, WAC. Administration was through the Army Service

Forces, Fifth Service Comand, and the 1545th Service Command. In addition to an administrative staff, four WAC officers were assigned as temporary faculty for each class.

Classes were held in the Chemical and Metallurgical Engineering Building, and the students were housed in Cary Hall South.

Instruction was by both the conference and lecture method. In the conferences, the class was divided into groups of fifteen, each with a faculty leader. Discussion of the administration of women in the Army was followed by a forum in which each group reported its opinion on the subject of the day. The lecture program was conducted by the WAC faculty and by members of the University staff, with special lectures by visiting men and women officers who were experts in particular fields. Subjects on which Purdue staff members lectured were principles of personnel management, principles of psychology, current history, and factors pertaining to WAC personnel during the readjustment and demobilization period.

After morning and afternoon sessions of lectures, conferences, and forums, one or two hours each afternoon were devoted to recreational activity, of which a total of 18 hours was required during the course. In the evening a lecture in current history was given immediately after dinner. This was followed by an optional attendance at films pertaining to the women's services. During the last few classes, a total of 26 officers of the U. S. Coast Guard, Women's Reserve (SPARS) attended as students.

Flight Training. What might be called the first defense training program at Purdue began at one o'clock in the afternoon of February 16, 1939, when a Purdue student took to the air at the Purdue University Airport. He, but one of the thousands trained in a program inaugurated by the Civil Aeronautics Administration, was three weeks ahead of any other trainee in any other institution in the nation. His flight marked the begining of an era of increasing activity at the Airport, in which facilities were expanded and students in increasing numbers were enrolled in the training courses. By June 30, 1942, more than 500 students had been graduated from seven types of flight-training programs. Among the students trained was one who as a lieutenant won the Distinguished Flying Cross for shooting down four Jap planes during the attack on Pearl Harbor.

When war arrived, the Airport became a center for the training of military fliers. Three groups were trained and graduated: 28 pilots from the Army Enlisted Reserve Corps, 534 from the Navy V-5, and 166 from the War Training Service flight instructors' school. The contingent of planes increased until it numbered about 60, and during the busiest times about 40 civilian instructors and an equal number of ground personnel were employed.

The facilities of the Airport were later turned to the training of young men from eight South and Central American countries in airline and fixed base operations. These students were selected on a competitive basis from those who volunteered to take qualifying tests. About 85 completed the ten months of training.

All this activity in aeronautics stemmed from a far-sighted move made in 1930 when the President of the Board of Trustees, the late David E. Ross, gave a large tract of land to Purdue with the recommendation that it and the adjoining farm tracts be set aside for the development of an airport. The first hangar was completed in September, 1934. Within the last several years long, hard-surfaced runways have been laid out, a second hangar has been completed, and laboratories for engine research have been constructed. These facilities not only had their usefulness during the war in training of fliers and technical students; their development was culminated in the founding of a new school at Purdue, the School of Aeronautics. Plans now call for further expansion and improvements.

The Diesel Engine Officer Training School. In July, 1942, the Navy, after ten-day notice, sent 25 warrant officers to the campus for a course in the operation of diesel engines. Other groups followed, and the training continued until February, 1943, the total number who took the course having been about 200. The warrant officers in early groups had had experience with Navy equipment. Later groups were composed of newly commissioned officers who, though somewhat better qualified educationally, did not have any Navy experience.

The School of Mechanical and Aeronautical Engineering was responsible for almost all the instruction as well as the course content, which was patterned after a brief outline furnished by the Navy. Five ensigns who had completed training in similar schools were sent to Purdue to assist with the laboratory instruction. The trainees took courses in the history and development of diesel engines, ship construction, the theory of diesels, fuels, lubricants, air-compressors, cooling systems, electricity, and engine maintenance-repair and operation and testing. After leaving the school the officers were sent on active sea duty.

Air Corps Squadron Engineering Officers. In January, 1941, the first of two groups of officers began a three-month course in engineering as applied to aircraft maintenance. Instruction, under the charge of the School of Mechanical and Aeronautical Engineering, was given to a total of about 100. This type of training was discontinued here after facilities had been prepared at various Army schools, and the Purdue records were transferred to Chanute Field.

War Training for Industry

It became apparent in the days of National Defense that, if the nation had to fight a war, industry would require vastly increased numbers of trained workers. This realization brought about the formation, under the U. S. Office of Education, of three federally financed, college-level training programs: Engineering Defense Training (EDT), Engineering-Science-Management Defense Training (ESMDT), and Engineering-Science-Management War Training (ESMWT). These programs began in December, 1940, and continued until June 30, 1945. Purdue University was a leader among the colleges and universities participating. In four and one half years of intense activity, in more than 100 towns and cities in nearly every section of the state, it organized and directed training for about 60,000 students in approximately 2,660 classes.

At Purdue the training for industry began with the establishment of the Defense Training Office—later the War Training Office—on the second floor of the Service and Stores Building. In the beginning, this Office administered the program directly; but, as the number of classes requested by industry increased, district offices were established in Evansville, Fort Wayne, East Chicago, Indianapolis, Lafayette, Muncie, and Jeffersonville and sub-offices in Marion, Gary, and Hammond. The head of the Department of General Engineering became the Director of the programs, and other personnel were drawn from staff members of the University and from outside. When the training reached its most active stage, from 35 to 40 persons were required at headquarters on the campus.

By far the largest part of the training was done in the industrial centers in classes held in high schools, college buildings, and the war plants themselves. A number of groups, however, came to Purdue and were trained in the Purdue classrooms and laboratories, groups described in the section titled War Training on the Campus. The War Training Office, in addition to administering the programs sponsored by the U. S. Office of Education, served as a coordinating agency for such special groups as the RCA Cadettes and the Electricians' Mates, who were trained under other auspices.

The training programs for industry grew with mushroom speed. Under EDT, classes enrolling approximately 3,200 students were conducted in fourteen industrial centers. In the fiscal year 1941-42, under ESMDT, about 1000 classes in 165 subjects were held in 68 Indiana cities, the number of trainees having risen to more than 21,000. In the next year, under ESMWT, employees from nearly 1000 plants were among the 20,000 persons enrolled in classes. Thus in about two and a half years of operation, during the critical period when the factories were swinging into war production, somewhat more than 44,000 workers were trained. A decline in the level of training followed, principally because of longer working hours in critical industrial areas, a growing realization that high wages were available without further training, and a sharp reduction in the number of eligible trainees.

In the EDT program many of the resident University staff instructed in the training classes, but later programs for the most part employed teachers from industry who were college graduates or who had had much industrial experience in the field in which they were certified to teach. By June, 1943, about 800 instructors, assistants, and laboratory teachers had been employed and a capable veteran staff had been built up in almost every industrial center of the state.

One contribution of the Purdue staff deserves special mention: about 90 per cent of the course outlines were prepared by specialists on the campus. The remaining 10 per cent were prepared by industrial personnel working by themselves or in collaboration with Purdue staff members. These outlines detailed what was to be taught and how it was to be taught, gave the course content class period by class period, and listed the textbooks and materials needed.

The training given was what was called terminal training; that is, when a student concluded a course he was prepared to do a specific industrial job. In the ESMWT program more than 150 courses were available. Initially most courses lasted twelve weeks and met in two three-hour periods a week. Changed industrial conditions, as well as better teaching techniques, reduced many of these courses to a total of 48 hours, most of them meeting one evening a week. The need for many of the more general courses continued from the first, and repeated demands made it possible to revise and improve outlines and teaching materials. Instructional aids were developed so that almost every course had a complete kit available throughout the operation of a class or, through scheduling, the kit was on hand when needed.

As the names of the programs imply, instruction was offered in the broad fields of engineering, science, and management. These broad fields were divided into chemical, civil, industrial, electrical, metallurgical, and mechanical engineering and engineering fundamentals, manufacturing processes, and related engineering sciences.

Developments in the war training paralleled developments in war industry, and the administrators, keeping in touch with the changing times, saw to it that courses were offered when and where they were needed. The factory shifting from peacetime to wartime production needed new workers for new jobs, and the War Training Office took the responsibility of knowing what those jobs were and having teachers and courses ready to train workers to fill them.

A special course, Textile Testing, was given to personnel of the Jeffersonville Quartermaster Depot to familiarize textile testers with the significance of tests.

Employees of the ship-building industry learned of the theory and practices of surveying in ship construction in a course titled Surveying for Ship Construction. Several classes were held in the Principles of Ship Fitting, another course offered for the ship-building industry.

Many courses in metallurgy, of which Production Metallurgy was probably the most important, were offered throughout the state. The general concentration was in the Calumet region.

Plastics in Construction gave engineers and others associated with the industrial fabrication and use of plastic materials a general working knowledge of the properties and technology of plastics and their application in the production of war products. Classes were held in many Indiana cities, including Indianapolis, Evansville, Jeffersonville, New Castle, Fort Wayne, and Hammond.

About one sixth of all the trainees were registered in courses in electrical engineering. Basic courses in direct-current and alternating-current theory and machinery were given in many cities but were concentrated in the Calumet, Fort Wayne, and Indianapolis areas. Basic courses in communication concerned with radio and electronics were given in the cities that had industries to which the training applied — Fort Wayne, Muncie, Marion, Indianapolis, Bloomington, Kokomo, and the cities in the Calumet area. Advanced courses dealing with power, electronics, and radio were given in the principal manufacturing centers.

Approximately another sixth of the trainees were enrolled in courses in chemical and metallurgical, mechanical, aeronautical, and civil engineering.

About a third sixth took courses in the related sciences, mathematics, physics, and chemistry.

Nearly one half were enrolled in courses in engineering drawing, industrial management, and manufacturing processes. The courses in drawing attracted many students because of the need in industry for tracers, detail draftsmen, elementary designers, and production workers who could interpret drawings. In industrial management such courses as those in motion-and-time study and industrial safety were needed for the training of new supervisory workers, these courses frequently leading to the upgrading of technical workers to supervisory positions. Certain courses in manufacturing processes—Jig and Fixture Design, Precision Measurements in the Machine Industry, Gear Fundamentals, etc.—were offered in many Indiana cities in which machine industries were dominant. To cite a specific example, personnel from companies manufacturing aircraft took a special course titled Principles and Practices of Aircraft Construction.

In the summer of 1942, a full-time course of study was developed to give high-school graduates who did not expect to go to college but who had completed an academic course some fundamental training in engineering that would fit them more quickly into industrial positions of responsibility. Classes were held in eight Indiana cities over a term of ten weeks of 42 hours each. The subjects studied were engineering physics, the fundamentals of engineering chemistry, engineering drafting, engineering materials, and engineering mathematics. Industry welcomed the 166 students who completed the schedule successfully; in fact, four or five times that number could have been employed had they been available.

The educational background of the trainees varied widely, from a complete lack of high-school training to post-graduate work leading to advanced college degrees. High-school graduates comprised the greatest percentage of the total. Since the training was on the college level, the minimum prerequisite was high-school graduation or its equivalent. Persons admitted on the "equivalent" basis usually had been engaged in industry for a number of years and had supplemented their formal training through home-study or correspondence courses.

As men were called into the Army and the Navy, women took their places in the factories and, to some extent, in the training programs. In the first year of ESMWT more than 4500 women were enrolled. Calls to the services also made for a heavy turnover among the district-representative staffs, which originally were made up almost entirely of graduates of teachers colleges. The younger men were replaced by older, and some attempts were made to use women in these positions.

The program tended to concentrate in the larger industrial areas. During the first year many classes were held in small, one-factory towns throughout the state; but when these towns did not receive war contracts, war training became unimportant to them. By the year 1943-44 the number of towns and cities in which courses were held had declined from about 100 to about 25, but those remaining were among the largest cities in the state.

With the passage of time, classes became slightly smaller on the average; but the type of student who was merely curious, and therefore temporary, tended not to enroll. Stricter eligibility requirements, in fact, limited enrollments to persons actually employed in industry; and though the classes were smaller, they were made up of better qualified students, with the result that a much higher percentage completed the courses for a certificate. Another development brought an increasing percentage of in-service classes given within a plant to employees of that plant only. Many of the in-service classes were given on company time, and the companies purchased the textbooks and other material required. That, of course, showed an increasing appreciation of the kind of training given.

In Indianapolis the program was strengthened by the acquirement on a two-year lease of the former Hoosier Athletic Club to serve as a center not only for the ESMWT classes but also for the Technical Institutes and other classes. The location of the building made it easily accessible; and with but minor changes it was possible to install a chemical laboratory, a laboratory for time-and-motion study, and about 15 classrooms. This building, later deeded to the University, is now known as the Purdue-Marott Agricultural Center.

To the University the war-training program brought many intangible benefits. It created a wealth of experience in technical extension and made for the University many valuable contacts throughout Indiana industry. A more tangible benefit was the transfer to the University of about

$100,000 worth of equipment purchased by federal funds and used in the program. Much of this material will be valuable in future instruction, both on and off the campus.

Tribute to the worth of EDT, ESMDT, and ESMWT was expressed in many letters from industry praising the services given by the University. These letters told how the training, because of the greater efficiency of personnel, had increased both the quality and the quantity of production; how trained workers had been made available quickly; how workers themselves benefited through promotions; how specific training in specific skills prepared workers for difficult jobs; how savings in materials were made possible; and how conversion to war work was greatly speeded.

OTHER WAR TRAINING ON THE CAMPUS

The War Department Civilian Protection School. Five different types of courses were given on the Campus under the auspices of the Office of Civilian Defense. Representatives came to these schools from the Second, Third, Fourth, Fifth, Sixth, Seventh, and Ninth Regions, into which OCD divided the country, and from Winnipeg, Canada. Attendance between June 14, 1942, the opening date, and June 25, 1943, the closing date, was 1265. The chief scene of outdoor operations was on the hill near the Ross-Ade Stadium, where demonstrations were held of the techniques for fighting such weapons as the incendiary bomb.

Ultra-High Frequency Techniques. Approximately 300 persons received pre-radar training in ultra-high frequency techniques in a course first offered under the ESMDT-ESMWT program and later continued as part of the regular curriculum in the School of Electrical Engineering. For a time at least the demand by the Armed Forces and by industry for persons with this training seemed unlimited.

Among those trained at Purdue were civilian, V-12, and ASTP students, Army and Navy officers, and staff members. The first course at Purdue was begun in January, 1942.

The Chemistry of Powder and Explosives. One of the courses offered through the War Training Office that demonstrated how the war-training program for industry kept pace with changing conditions was titled the Chemistry of Powder and Explosives. It was needed when the new munitions plants were being built, even before the opening of hostilities, and was designed to train laboratory and supervisory workers in commercial methods of handling, testing, and manufacturing munitions and explosives. Two groups of students in this course were trained on the campus, the first having begun work in June, 1941. The number trained here totaled about 80, and others were trained in Indianapolis, Jeffersonville, and Kingsbury.

Ordnance Inspection. Through the War Training Office three groups of students hired through Civil Service were brought to the campus and trained in ordnance inspection for the Cincinnati Ordnance District. Similar on-campus training was given to a group from the Victory Ordnance Plant at Decatur, Illinois. Total enrollment was about 120. The courses given were in mathematics, blueprint reading and sketching, materials of industry, manufacturing processes, inspection practice and specifications, and engineering testing. The first class was begun in March, 1942, and the last concluded in November of the same year.

Engineering Aides for Wright Field. In July, 1942, sixty boys who had been hired through Civil Service arrived for a 24-week course that would qualify them to be engineering aides at Wright Field, Dayton, Ohio. The training period was divided into three eight-week periods in which 16 courses were offered, including courses in the use of the slide rule, shop practice, and manufacturing methods. The School of Electrical Engineering was largely responsible for instruction and course material. The boys worked 48 hours a week.

Succeeding groups of 47 and 53 were composed of young women who for the most part had had some college training. Despite a lack of experience in basic engineering, these women completed their courses in a highly satisfactory way and rendered valuable service to their employers as aides to engineers.

Quality Control. Statistical methods of quality control were developed during the war years by some of the nation's leading industries with the co-operation of the Army and Navy and other government agencies. When intricate instruments of warfare were being produced by the hundred thousand through the labor, frequently, of hitherto unskilled workmen, some dependable and quick method of assuring quality was essential. Random sampling obviously would not do. The statistical methods of quality control resulted in the improvement of the product, economies in the use of men and materials, and a decrease in the number of rejections and in inspection costs.

To help spread the use of these methods, the University conducted, through ESMWT, a one-week school in the spring of 1944 under the direction of a professor in the Department of Mathematics, who had the assistance of two men of the Office of Production Research and Development. About 30 persons from other institutions and about 60 representatives of industry attended the school. A one-day conference followed, with an attendance of about 250.

Men in the Army Training Program Leaving Cary Hall. At the peak of the Army training 1,348 men were enrolled at Purdue.

An Inspection of the Navy-WTS Flight Instructors' School. Aviators in this group were among the more than 725 service personnel who had flight training at the Purdue Airport.

Cadettes Learning Drafting. Enrolled at Purdue as special students, these young women were among the nearly 500 who were trained for technical work ordinarily done by men.

A Session of the School for WAC Personnel Administration. More than 800 officers of the WAC and the SPARS attended this War Department School on the Purdue Campus.

Statistical methods of quality control were also taught in such industrial centers as Gary, Fort Wayne, Muncie, Hagerstown, and Indianapolis, and some members of the on-campus conference were quite active in "continuation meetings."

Curtiss-Wright Cadettes. Purdue University was one of seven schools selected by the Curtiss-Wright Corporation to train young women for engineering duties and responsibilities that had normally been assigned to graduates of engineering schools. The first course, an intensive 44-week training program, was begun in February, 1943, the curriculum having been developed jointly by representatives of the Corporation and the seven schools. The Cadettes, as they came to be called, attended classes 40 hours a week, studying such subjects as engineering mathematics, the properties and processing of aircraft materials, and the elements of drawing.

The second and third courses given to later groups of Cadettes lasted only 24 weeks each, and the emphasis in the training was on the development of skill in drafting. Commencement exercises for the third and last group were held in the Memorial Union Building on March 23, 1945. On leaving the campus, the Cadettes, of whom Purdue trained a total of 258, reported for work in plants of the Curtiss-Wright Corporation.

RCA Cadettes. The Radio Corporation of America also chose Purdue University to do the training of women for war work in its plants. A first course was completed in February, 1944, when 73 Cadettes received certificates after 44 weeks of training in electronics and the supplementary subjects of mechanics, mathematics, shop, and drafting. In the RCA program 137 Cadettes received certificates and departed for jobs in various plants of the Corporation.

In general, the Cadettes from RCA and Curtiss-Wright had had some college training before being recruited for their technical training at Purdue. They came from many states and were of college-girl age. While in training, they were registered as special students, were quartered in the Women's Residence Halls, Terry House, and University House, and were required to carry a heavy schedule. RCA and Curtiss-Wright paid for the program and also paid the young women a nominal salary.

Chapter III

RESEARCH IN SCIENCE AND ENGINEERING

The Engineering Experiment Station

When, in 1917, the Engineering Experiment Station was organized, one of its chief purposes was to be of service to industry, to offer to industry an opportunity to profit by the specialized knowledge of experts in the various fields of engineering. During the years that purpose has been abundantly fulfilled. The reports for all those years show many services rendered, from the testing of minor articles to major research. The Station has greatly aided the University in meeting the expressed and implied obligations of the mandate of the original Morrill Act of 1862, "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life." With the arrival of war, most of the work of the Station was directed at solving some of the problems that could best be answered by trained engineers and scientists.

The war research sponsored by the Station was conducted by the Station itself, by the several engineering schools and departments, and by engineering undergraduate and graduate students. Included in this research were projects conducted in co-operation with the Armed Forces, war industries, governmental agencies such as the National Defense Research Committee, and the Purdue Research Foundation. These projects are described or mentioned under the headings of the various divisions and schools of engineering.

No account of the work of the Station would be complete without reference to the cumulative effect of the research sponsored by the Station in normal years. This research has been extensive, as evidenced by the annual reports in which have been detailed the many research projects integrated with the state and national economy. To list these projects here would require many pages and would exceed the scope defined for this volume. The projects, nevertheless, had their wartime importance and were instrumental in providing a backlog of science and engineering for the intense industrial work of the war years. Some of them had a direct application to the war effort; others helped to ready the engineering staff and laboratories for timely research on war projects; still others belonged in that great classification by which industry was supplied with new information and helped to keep in step with technological progress.

Like the Purdue Research Foundation, the Station has not considered research as an end sufficient unto itself alone. Rather, the Station has met an obligation in the training of both graduate and undergraduate students for taking their places in this complex and difficult modern world. As a consequence, it has performed a major educational service through its alert efforts to provide problems and funds for both undergraduate and graduate study. A part of its worth must be evaluated in terms of the men and women it has helped to train.

THE DEPARTMENT OF RESEARCH RELATIONS WITH INDUSTRY AND THE PURDUE RESEARCH FOUNDATION

The Department of Research Relations with Industry and the Purdue Research Foundation were created, in 1928 and 1930 respectively, for the broad general purpose of promoting research as a means of education. To achieve this end, these two agencies have brought to the campus, under commercial and governmental sponsorship, scientific and industrial problems of a fundamental nature for solution by graduate students working under the direction of creative scholars. Thus the University has been enabled to reach the high goal of training capable young men and women as creative thinkers and leaders in effective search for scientific truth—the truth that is the key to the productive power of the nation. Graduate education without research has not been the University's aim, nor has been research without graduate education. The Department and the Foundation have been instruments by which young people in training might have both.

During the war when research became a pressing necessity in a nation transforming itself into a war power, the Foundation and Department proved indispensable in bringing to the University the problems and the funds through which a large part of the University's contribution in research was made. In essence, the function of the Department and the Foundation was to co-operate in determining what research needed to be done and where it could be done on the campus and to contract with an external agency for the doing of that research. By this means provisions were made for laboratories, equipment, and raw materials, graduate students were supported on their way to advanced degrees, new productive creative leaders were developed, and the University's creative scholars were given an outlet for their skills and talents as teachers and research workers.

In the report for the fiscal year of 1945-46 the financial history of the Department and the Foundation was summarized. Funds from 51 sources had provided almost a million and a half dollars for research projects in chemistry alone, for a total of 297 fellowship years. Of this sum, about 64 percent was pledged during the war years of 1943, 1944, and 1945. The pledges from civilian and federal sources were approximately equal during the war period. About three times the sum reported for chemistry had been pledged by external agencies for Department- and Foundation-sponsored projects throughout the University, to finance the graduate research of nearly fifty per cent of all Purdue graduates receiving the doctor's degree during recent years.

Associated with the Department is the Purdue Research Foundation Housing Research Campus, established by the Foundation after Mr. David E. Ross early in 1932 made the first gift of the 184-acre Foundation Housing Research Campus for the development of "rational living research." Here the aim has been the development of satisfactory homes to be built at low initial expense and maintained at low operating cost. Close co-operation with industry has been maintained for the solution of more or less basic problems, and fundamental scientific research has been directed toward the discovery of new concepts relating to homes as a whole. Grants from both government and industry have been used for the erection of experimental houses that have demonstrated that new materials, new combinations of materials, and new techniques are possible and practicable.

Included among the researches have been studies of radiant heating, newly created steel lumber, heating controls, panel heating, solar heating, and the control of water vapor in tightly built homes. Developments have led to fulfillment of the Foundation's fundamental purpose—the training in research of advanced students under expert professional direction.

Early in the war, under a grant from the Office of Production Research and Development, the Department erected four experimental houses, at least one of which deserves special mention. This house, meeting rigid specifications as to strength, capacity, and fire resistance, could be constructed in a few days at a cost for labor and material of $1500 to $1600. Through the co-operation of the School of Home Economics, it was furnished for less than $200, exclusive of the gas range and the refrigerator. Experimental work of this kind, run in co-operation with industry and government and directed by scientists on the campus, will carry an increasing weight during the years that lie ahead.

The Department is also responsible for the establishment, in October, 1930, of the Purdue University Airport and for its development and expansion. The Purdue Aeronautics Corporation was incorporated on June 30, 1942, to handle the rapidly increasing demands requiring a skilled operating staff. The wisdom behind the creation of these facilities was amply demonstrated during the war years when the Airport became a center for both flight training and research, and will be demonstrated in the future through the programs of the new School of Aeronautics.

THE DEPARTMENT OF BIOLOGY

In co-operation with the Food Subsistence Laboratory of the Quartermaster Corps, U. S. Army, and the Agricultural Experiment Station, the Department of Biology conducted studies to learn what part, if any, bacteria played in the development of off-flavors in stored dried eggs. The drying operation leaving the bacteria in a weakened state in which they could not be counted by ordinary means, a principal technical result was the establishment of a method by which reliable counts could be made of bacteria in the processed eggs. This method involved the reviving of the bacteria in a medium of yeast water added to a glucose-tryptone medium. Another result was the identification of the bacteria most frequently found in dried-egg powder.

Dried eggs supplied by the Quartermaster Corps were loose-packed and compressed-packed in different types of containers and held in storage at different temperatures for a period of three months. Data revealed that at the higher storage temperatures the total bacterial counts decreased with time, an indication that bacteria were not present in sufficient numbers to cause spoilage of eggs shipped to tropical countries. The packages considered in this research had no significant effect on the bacteria surviving in the stored eggs, one package being about as effective as another. Whether the dried eggs were compressed or packed loosely also made little difference in the kinds and numbers of bacteria that survived.

In other research related to the war, the Department conducted physiological investigations with laboratory animals exposed to simulated high altitudes. White mice and other animals were subjected to low oxygen atmospheres produced by decompression, so that factors affecting survival in rarefied air could be determined. It was found that temperature was highly significant, that water-starvation increased resistance, and that tolerance increased when the rate of decompression (rate of ascent) was slow.

THE DEPARTMENT OF CHEMISTRY

War research in the Department of Chemistry was conducted for the U. S. Army, the U. S. Naval Research Laboratory, the Army Air Forces, the Office of Scientific Research and Development, and a number of industries that came to the Department for assistance in the solution of wartime problems. This research began early, in the summer of 1940, and by the end of January, 1942, twenty-two graduate students and five full-time professors were engaged in full-time research work related to war and wartime industry. One expansion followed another. In September, 1943, it was reported that 59 men and women were employed full time on fellowships while 15 were on a part-time basis. The Department, it was gratifying to learn, developed processes in competition with some of the best university and industrial research laboratories of the United States and our allies, processes that went into commercial production for the war effort and replaced those developed elsewhere. Security requirements necessarily screen some of the work that was done, but it may be said that almost every type of war problem of a chemical nature was under investigation here on the campus.

How large the program became was symbolized by a notice posted in a section of hallway:

> Because of the crowded conditions in this building due to the war emergency, it is necessary to use this area as an office. Please regard it as such and refrain from unnecessary visiting and other disturbances which might decrease the efficiency of personnel.

Other evidence of the wartime expansion was the re-equipping of the old Locomotive Testing Laboratory for war research. The historic test locomotive, Vauclain-Purdue No. 4, itself went to war as scrap, the occasion not being without its nostalgic memories.

After the war 52 members of the staff who participated in war research received citations from the U. S. War Department and the Office of Scientific Research and Development. Bronze lapel buttons were awarded for service of more than six but less than eighteen months, and silver for more than eighteen months.

With the research went the training of graduate students through experience with the problems under investigation. To these students, the Department is careful to state, must go a good share of the credit for the accomplishments. Their part was to learn as they worked and at the same time to produce. The Department had good success with this method of training. In 1943-1944 twenty-five men and women were awarded the degree of Ph. D. in chemistry, the group forming more than one eighth of all granted the degree by American universities in that year. In the next year, however, the slump in enrollment and the increasing difficulty of gaining deferment even for young scientists resulted in only 11 Ph. D.'s being graduated in chemistry.

Early announcement was made of a process for the synthesis of menthol capable of making this country independent of Japan for its supply of the product. Co-operative research in ten months yielded a sample that passed inspection.

In June, 1945, announcement was made of the successful operation of a plant for the production of ethyl chloride by the chlorination of ethane. The ethyl chloride was needed to produce tetra-ethyl lead, needed to increase the anti-knock rating of gasoline. The manufacturing process employed was an outgrowth of research fellowships at Purdue.

Fluorination and Atomic Energy. Early in 1942 Purdue chemists were called in as consultants on that most awesome of the war's scientific ventures, the development of atomic energy for military purposes. In June of the same year, the Department, because of its background of experience in fluorine chemistry, was asked to accept, through the Purdue Research Foundation, a small contract to investigate the preparation of the bis (trifluoromethyl) benzenes, of which there are three isomers, and two of the three isomeric tris (trifluoromethyl) benzenes. These materials were to be used as intermediates in the preparation of the corresponding fluorocarbons—i. e., compounds containing only carbon and fluorine. Before the contract was four months old, the budget was increased and the scope of the research expanded to include an investigation of methods for the preparation of fluorocarbons.

These materials were not only new materials but they were also products essential for the operation of one of the huge plants at Oak Ridge, Tennessee, in which the isotope U-235 was separated from the isotope U-238.

The preparation of perfluoroheptane, one of the desired fluorocarbons, by reacting heptane with elemental fluorine was investigated at Columbia University. Since fluorine reacts with most organic materials with explosive violence, even at low temperatures, another procedure was desired for use in large-scale production. Purdue chemists, along with others, found that certain metal fluorides, prepared by the use of fluorine, give a smooth reaction with heptane and with other hydrocarbons. As a result of this reaction fluorocarbons were obtained. A process utilizing this reaction was adopted for the commercial production of perfluoroheptane.

At the beginning of the investigation, fluorine was being made in small amounts at an estimated cost of about $75 per pound. Because of the difficulty in its preparation and of its highly corrosive nature, there was considerable doubt that it could be produced in the quantity necessary for the production of the desired materials. Therefore it seemed desirable to find methods for the preparation of fluorocarbons using as little fluorine as possible. Purdue chemists proposed using hydrogen fluoride available in quantity at 15 cents per pound. Several possibilities were investigated; a process was developed for the preparation of bis (trifluoromethyl) benzene, which was carried out in approximately a two-and-one-half-million-dollar plant at Niagara Falls. This compound was then converted to the fluorocarbon dimethylcyclohexane in a New Jersey plant costing approximately forty million dollars.

Later, Purdue chemists developed an alternate and a standby process which produces both perfluoroheptane and an alternate for perfluorodimethylcyclohexane. In this process, which was operated in pilot plants, a relatively small amount of a fluorinating agent which required fluorine for its preparation was needed. Details about it and about many variations in procedures would be more appropriate in a paper for chemists than for presentation here.

It might be said, by way of interpolation, that organic fluorine-containing compounds offer tremendous scientific and industrial possibilities. Fluorocarbons, for example, are the most stable known organic compounds. They fail to react with most substances and they are non-inflammable. The prediction may be made that many fluorine-containing medicinals will appear in the future, for at Purdue a fluorine-containing compound has already been developed that possesses properties approaching those of an ideal anesthetic. Many more fluorine-containing compounds are theoretically possible than all the compounds known today. Since there are more than 300,000 known compounds, research workers in fluorination are not likely to run out of problems.

When the Purdue chemists were about to finish their work on the preparation of fluorocarbons, they were asked to help with the chemical problems associated with another of the processes for the separation of the isotope U-235 and U-238. Security regulations, at the time of this writing, do not permit a discussion of the work done in connection with the process. However, it may be said that in general the investigations were concerned with the recovery of uranium.

The Purdue chemists did about an equal amount of research on both problems. In all, counting graduate students, service staff, and members of the permanent staff, more than 100 persons were employed on the project, with a budget of more than $700,000.

Synthetic Rubber. Chemistry's work on synthetic rubber for war purposes began in July, 1942, after industrial representatives came to the Purdue Research Foundation with the suggestion that a fellowship be established for the chemical study of synthetic rubber. Initially three graduate students under professional direction worked on the program. Later, as the value of the results became established, the program was expanded until ten graduate students were included in it.

All parts of the synthetic rubber problem could be and were tackled at Purdue—from the production of raw materials, through polymerization and curing, to the testing of the finished products. Early efforts were concentrated on matters of immediate concern, the objective being to help industry on troublesome points that were interfering with production. Throughout the program assistance was given to commercial research when special problems were brought to the University for solution.

Investigations of direct aid to industry involved rates of polymerization and methods of determining them, studies of new modifiers and catalysts for the polymerization process, and studies of multimonomer systems. Synthetic rubber is produced from a complex mixture of ten or twelve different substances, each one a variable in the manufacturing process; and industry needed, and received from Purdue, essential data on how the variables in different proportions affected relative rates of polymerization. Purdue also supplied data on the relationship between the composition and the properties of synthetic rubbers, the rubbers being like metal alloys in that they had good properties within certain ranges. Other immediate problems of more complicated nature were also solved.

When the period of urgency had passed, the scope of the research was extended to include attacks on more basic problems. Of major importance was the preparation of a number of new kinds of rubber, their development having been part of the national effort to find synthetic rubbers suitable for many and various purposes. Work was also done on the improvement of processes for obtaining raw materials for polymerization into rubber, work that resulted in a highly promising process for the production of a dichlorostyrene. Toward the end of the war the program specialized on new types of materials that could be converted into synthetic rubbers and plastics. Another achievement was the development of an emulsion polymerization process for making the type of rubber (butyl) that is used in the manufacture of inner tubes.

Only those technical men who worked on synthetic rubber have a full appreciation of the tremendous number of problems that had to be solved in a hurry at the outbreak of war. Before hostilities began, crude rubber was this country's largest single import, both in the amount of money involved and in the tonnage delivered. A stockpile sufficient to last a limited time was on hand, but, beyond question, much of the rubber for the duration would have to be made synthetically. Readers will probably have little trouble recalling the days of Jeffers the Rubber Czar and the arguments that raged in the newspapers over the relative merits of alcohol and petroleum as raw materials for the production of butadiene.

Synthetic rubber had been under study since the latter half of the nineteenth century, but not until the 1930's were the products obtained satisfactory for use in tires. Of several promising types discovered, one, designated GR-S (Government Rubber-Styrene), was chosen as the principal type to be made. The pressure of war forced development to jump from the pilot-plant stage to large-scale production, eventually to 1,000,000 tons a year—enough to cover two or three city blocks to the height of the Washington Monument. Between the inception of the development and attainment of success lay a vast amount of rush research in which Purdue had an active part.

The Department of Chemistry did not abandon its synthetic rubber program at the end of the war. Research is still being continued, with its accompanying training of men for a large new industry, but the emphasis has been shifted towards the solution of long-range, fundamental problems.

Antimalarials. The search in the Department of Chemistry for a synthetic drug superior to quinine or atabrine in the treatment of malaria began in February, 1941. At the beginning, before Japanese seizure of sources of supply in the Netherlands East Indies, three graduate students did their research on the problem. This number gradually rose to seven as the need for a better antimalarial became more and more pressing. A vigorous exploratory program resulted in the preparation of about 200 new compounds, many of which were judged worthy of being tested on birds infected with malaria. Some proved to be active, and others very active, against the disease.

One method used at Purdue was that of keeping and strengthening the active parts of the quinine and atabrine molecules and eliminating parts that caused toxic effects. Quinine, which was in extremely limited supply, had long been considered the best all-around antimalarial, yet it sometimes caused stomach upsets and a ringing in the ears. Atabrine, a synthetic discovered in Germany in the 1930's, also caused stomach upsets and had the marked disadvantage of turning the skin yellow. Most important of all, neither drug would act as a prophylactic—that is, as a disease preventive—or prevent relapses from occurring. By varying the molecular structure of the two drugs, the chemists prepared similar compounds, hoping by the method of cut and try, seasoned with scientific judgment and analysis, to find the drug or drugs that would be the ultimate answer.

Underlying basis for the search was the chemists' faith that, if a product is found in nature which in part meets the needs of humanity, a better product to meet the same needs can be made in the laboratory. Quinine, derived from the bark of the cinchona tree, serves some purpose of the tree and only by chance possesses the medicinal properties that make it a useful antimalarial. But it provided the clue that led to the discovery of atabrine; and the chemists believed it could be used as the starting point for the preparation of even better synthetics.

Estimates of the world incidence of malaria vary, but it is known that even in normal times the supply of antimalarials fell far short of meeting the demand. Malaria has become such an evil that from five to ten millions have died of it yearly, some areas of the world have been made almost uninhabitable, and the long-continued suffering and loss of vitality have cut the productivity of some peoples by as much as 50 per cent.

The chemists found the research to be heartbreaking. New compounds found to be effective in one respect were likely to be deficient in another. Possibly typical of the disappointments attending the search was an experience with a drug prepared at Purdue and designated as Purdue A. This drug was an analogue of plasmochin, a synthetic that had been used against malaria, and in tests on birds showed unusual activity. Hopes were buoyant until the drug was found to be unsuitable because it caused a chronic toxicity.

As a result of things learned in the past few years, research at Purdue has been turned in a new direction. Emergence of pharmacological properties has been found so unpredictable that new compounds need to be prepared and tests made of every new type of structure in the hope of finding new drugs.

Refrigerant, Insecticide Carrier. Dichlorodifluoromethane, a compound discovered near the beginning of the century, became a war product because of its value as an insecticide carrier and as a refrigerant aboard ships and submarines. It was in tight supply; yet the demand for it from the Armed Forces was heavy. There was good reason, then, to continue co-operative research begun in 1940 on a process which showed promise of greatly simplifying production. This investigation was related to other research in fluorination conducted within the Department.

Development began as a result of one of those fortunate accidents that have often led to important discoveries. New apparatus was being studied for the sole purpose of learning how to operate it. A compound being used in the study was not expected to react but did. Investigations made to determine why the reaction occurred opened the trail to the new process.

The results met expectations. A process was developed which, it was believed, was capable of producing high yields at small expenditures of material and labor.

Activated Carbon from Coal. A process that lends itself to semi-technical description was developed for the production of activated carbon (or charcoal, as it is sometimes called) from coal. Research on the chlorination of petroleum products, in which the Department of Chemistry has specialized, led to the belief that a study of the action of chlorine on coal might prove profitable for several reasons. During the first year the research ran into a blank wall, but persistence brought good results. Using cheap, domestic bituminous coal, the chemists were able to make an excellent activated carbon suitable for use in gas masks. Though not used for war production, the process was considered able to make this country independent of the supply of cocoanut shells from which activated carbon is ordinarily made.

Activated carbon has found wide use when it has been necessary to separate a small amount of one substance from a large amount of fluid in which it is dissolved. It is used, for example, to recover the dry-cleaning solvent from the air that dries clothes, to remove odors and tastes from water, and to remove gasoline from natural gas. In the gas mask the activated carbon retains the harmful vapors by liquefying them on its surface and holding the liquid there, in a process called adsorption. All materials will adsorb vapors to some extent; carbon has this property far more than most materials, and the activation of carbon, which has the effect of increasing its surface, further increases its adsorptive capacity. It has been estimated that a one-inch cube of activated carbon (with an apparent area of six square inches) has an area of one million square inches if the surface of the pores is considered.

The bituminous coal used in the research was crushed to about the size of peas, heated to a moderate temperature, and treated with chlorine for 24 hours. The chlorinated coal was made into pellets, which were baked to harden and then crushed to a size suitable for gas masks. The crushed pieces were heated to a very bright red and steam was passed over them for three hours to activate the carbon. Apparently, when the coal was treated with chlorine, the chlorine atoms combined with it; and later, on being released by the heat, they left pores behind into which gas could go to be adsorbed. The activated carbon produced was of a quality equal or superior to that of the best cocoanut-shell carbon, and hydrochloric acid and carbon tetrachloride were valuable by-products.

THE DEPARTMENT OF PHYSICS

During the war the staff of the Department of Physics was divided into three principal groups. One group went to the Radiation Laboratory of the Massachusetts Institute of Technology. Another went to the laboratories at Los Alamos, New Mexico, for work on atomic energy. The third group stayed on the campus to do war research and to carry a teaching load that reflected the demand of the Armed Forces for greater emphasis on physics. Still others not included in the three main groups were drawn to various laboratories and industries engaged in war research. As the physicists left the campus, staff members from other departments were enrolled in refresher courses so that instructors would be available for handling the load in basic instruction. Of the staff members of the Department who were at Purdue in 1940, sixty-two per cent in 1943 were engaged in war research on the campus or at other institutions. This put Purdue fourth in the list of physics departments in the country so far as active participation in the war effort was concerned.

What is remarkable about the war record of the Department of Physics is that, despite the loss of staff and the terrible shortage of competent replacements, the teaching load was carried, some fundamental research was continued, and the Department successfully completed a war research project of great value in the development of radar and engaged in a project in atomic energy that has not been described.

Fundamental research was continued within the several divisions of the Department and included research in spectroscopy, the structure of crystals, acoustics, and electron diffraction. But these continuing projects were on such an abstract level that no attempt will be made to give an account of them here. In a special project, run under a grant from the War Production Board, a number of men on the staff designed and built a new type of equipment for the investigation of reflectivity and behavior of various materials in the infra-red region.

Radar. After the close of the war, information formerly held in secrecy was released about the effectiveness of radar and of the developmental work at M. I. T., where the world's largest radar laboratory was established. The public was told of rapid, intensive research in microwave radar and of the delivery of radar sets in time for use in the Battle of Europe. Purdue contributed more physicists to the Radiation Laboratory than any other institution except M. I. T. itself. In the Purdue group were five staff members and four former staff members of the Department of Physics and one member of the Department of Mathematics. Staff members were granted leaves of absence as early as 1941. Still another member of the Department of Physics worked with radar for the National Research Council of Canada.

Germanium. The work of the Department of Physics on the solid state of matter attracted the attention of defense organizations, and under a contract between the Purdue Research Foundation and the National Defense Research Committee, the Department began research, three months after Pearl Harbor, on radar components. The research was directed toward an understanding of the action of rectifier crystals in microwave radar and the development of better crystals. Perhaps its most striking success was the development of a new material to replace the silicon crystals familiar to old-time radio "hams," crystals once displaced by radio tubes but now of great importance in microwave radar systems. This new material was germanium, an element closely related to silicon and formerly available only in fractions of a gram. Like silicon, it is what is known as a semiconductor.

First of all, techniques for the large-scale production and purification of germanium were worked out, with such success that it became available in pure state by the pound. The properties of this substance were found to be very sensitive to the presence of impurities. By properly alloying it with small amounts of other materials, the Purdue physicists were able to make it either an excellent electrical conductor or a very poor one, and even to cause it to offer a "negative resistance" to alternating currents.

For use as a radio crystal germanium requires very careful processing, according to procedures devised by the Purdue group, but it possesses striking advantages over silicon for some purposes and is its equal in most other respects. Germanium crystals are in many ways far superior to conventional diode radio tubes and can even serve as oscillator tubes. Though they can conduct a much larger current than ordinary diodes, they are small, require no heater, and can be wired into a circuit like a resistor.

Another valuable and unexpected property of germanium crystals is reported as having led to radical changes in the design of high-performance microwave receivers. Numerous technical applications of germanium were devised by the Purdue physicists, and another important part of their work was the development of test equipment and test procedures for microwave radar crystals in general.

Since the Purdue physicists based their work on fundamental research, it is expected that in time numerous applications of their results will be made in communications, radio, and television.

Atomic Energy. Before the war the Division of Nuclear Physics was among the most active and progressive in the Department, as evidenced by an alert research program, the presenting of numerous papers, and the bringing to the campus of celebrated lecturers.

In 1935 plans were begun by the Department of Physics to build a cyclotron. The primary objective was to construct a compact instrument at the lowest possible cost. For this reason standard materials were used and much of the equipment was built in the departmental shop. As a result the Purdue cyclotron presented a number of features differing from others of the same size.

Almost nothing has been revealed about the work in the Department of Physics on the development of atomic energy for military purposes. The bare announcement was made in August, 1945, that through the Purdue Research Foundation funds had been secured in 1942 for one year's research work under the immediate direction of a Federal Government physicist and that nine University physicists were recruited for this work. Five of the nine were later transferred to New Mexico to participate in the activities culminating in the demonstration of the atomic bomb. Of one of these, Mr. Harry K. Daghlian, the tragic information was received that he had been killed in an industrial accident.

Physics in the Secondary Schools. Though not classifiable as technical research, the efforts of the Department to raise the level of the teaching of physics in the secondary schools were so extensive and timely that they are described here as a distinct war contribution. In 1939 the Head of the Department was made chairman of a committee of the American Association of Physics Teachers that was formed to study the teaching of secondary-school physics and to bring about a better co-ordination of the teaching of the natural sciences and mathematics in the schools. This committee, after preliminary investigations, was instrumental in the establishment of the Co-operative Committee on Science Teaching, which included representatives of chemistry, biology, and mathematics as well as physics. When war came, and with it an alarming shortage of scientifically trained manpower, the Co-operative Committee undertook the task of helping the secondary schools to give the practical training of most immediate consequence to industry and the services.

In physics the work done was concerned with the selection and preparation of teachers, the adaptation of curricula to War Department recommendations, and the development of teaching equipment. Included in this were many details pertaining to aptitude and screening tests, the testing of young women for training as teachers, the integration of physics courses with shop courses, and other matters relevant to getting the training done quickly and efficiently. One of the publications resulting from these extensive wartime studies had a circulation of 15,000.

The need was great. Despite America's preeminence in scientific progress, there had been a steady decline since the end of the last century in the percentage of high-school seniors enrolled in physics courses, and the total number of men and women trained in physics was only a small fraction of our population. The Army was reported to require more than fifty per cent of its men to have some technical skills, and the Navy to require an even higher percentage. Industry, of course, needed trained manpower on all levels. Since there was no hope of securing enough men and women from the universities and colleges, the secondary schools necessarily became the centers for preinduction training and for training which would help industry with its immediate production problems.

The committee in physics continued its work throughout the war and in January, 1945, was reorganized to include representatives from universities, colleges, junior colleges, and secondary schools and two representatives from industry. Thus, the teacher-training institutions, the teachers, and the industry employing the high-school graduates were all represented.

THE SCHOOL OF CIVIL ENGINEERING

The School of Civil Engineering engaged in artillery research mentioned under the heading, The School of Mechanical and Aeronautical Engineering. Other war research was done in its Joint Highway Research Department and its Materials Testing Laboratory.

The Joint Highway Research Project is sponsored by the State Highway Commission of Indiana and Purdue University. Its objective in the large is the construction in Indiana of safe, durable, and economical highways. To reach this goal, it has performed much basic research on highway problems and has trained men in the fundamentals of highway engineering. Through the laboratory method, combined with investigations and tests on highways themselves, it has developed information and techniques that have been applied to highway design, maintenance, and construction. Its researches have included soil studies, the building of test roads, evaluations of the materials used in concrete, tests of traffic paints, and ways of promoting traffic safety. The Project also serves as a clearing house for the engineering and scientific information that can be applied to good effect on the highway system.

After December 7, 1941, the Project found that its facilities, personnel, and experience could be turned to work associated directly and indirectly with the war effort. Busy years followed, and a record of substantial accomplishment was the result.

The meaning of much of the Project's contribution can be indicated through a brief account of what is meant by the term "engineering soils." To a farmer, the value of a soil depends largely on the soil's capacity to grow crops. To an engineer, a soil is something entirely different. Its value depends on what it will do in engineering uses. The engineer considers rocks, sand, gravel, clay, and silt to be soils. He is not much concerned with fertility but is vitally interested in all soil qualities related to the action of soils in subgrades, foundations, embankments, and many other applications. Whether an engineering job is a success or not is often determined by the skill or lack of skill with which the soils problem is solved.

One part of soil science deals with soil formation and soil patterns—with the how, when, and why of the reasons soils came to be what they are. This part explains the events of the glacial era and of the era when wind-blown soils were deposited in southern Indiana. It is not a theoretical matter but has been of invaluable help in the understanding of soils and in the solving of specific problems. It tells, for instance, the probable depth of the bed rock, the types of soil that will be encountered along a new highway route or at an airport site, and the location of granular deposits. In an application made some years ago, the Project found that poor service from a highway in northern Indiana could be attributed to the clay left in the bed of prehistoric Lake Chicago. At the same time highways that did not cross the bed of the lake, but followed its shoreline, were found to be giving good service because of the sandiness of the soils over which they were built.

From its study of soil formation and soil patterns, the Project developed the technique through which it made its most direct contribution to the war effort. This was the identification of soils by means of aerial photographs. The Project found that, given an aerial photograph of a region, it could determine quickly and with reasonable certainty the types and origins of the soils pictured, the topography of the land, and, hence, the suitability of the area for the construction of airports and highways. This interpretation, the Project learned, could be made for any area in the world, no matter how heavily the soils might be covered with vegetation or snow, and had a good chance of being valid even if it were made from photographs taken at altitudes as high as 30,000 feet.

A National Soil Map. When the wartime increase in aviation brought with it the demand that airport facilities be expanded, the Project was engaged by the CAA to make soil studies that led eventually to the preparation of a soil map of the entire nation and an interpretation manual that explained the technique of identifying soils from aerial photographs. The map outlined general soil areas, and used in conjunction with aerial photographs of specific sites, provided a quick method for learning how existing airports could be made larger and new airports could be advantageously located.

Information used in the preparation of the national soil map was gathered from aerial photographs and from geological and pedological sources. Inspection trips, on which soil samples were collected for laboratory analysis, were made to some areas when a check on the validity of the results obtained from aerial photographs seemed desirable.

Stabilization of Soils on Airport Runways. With the advent of war, airport designers became interested in low-cost materials for use in the construction of airport runways. One of the possibilities was the use of the natural soils on the site, provided the soils could be stabilized either mechanically or by the addition of some stabilizing admixture. The Project had done research on the stabilizing of soils, and so was ready for a contract with the CAA specifying that it should determine the effect of some forty admixture combinations upon the stability of six different types of soil under specified conditions. During the year and a half in which the study was conducted, more than 2000 specimens, comprising some six tons of processed soil and stabilizing materials, were molded, cured, and tested. The final report on the study was submitted in January, 1944.

The supporting power of airport runways had been found to be dependent in part on the strength of the soil at the site. Some soils in their natural state were strong enough to serve as subbase materials, but others required treatment if they were effectively to support their pavements. The treatments the Project investigated were concerned with the addition to natural soils of portland cement, bituminous materials, and chemicals. These substances were known to strengthen soils, but additional information about their effect was needed. The stability of certain cement-soil combinations, for instance, was a doubtful matter when the combinations were subjected to freezing and thawing.

After the specimens had been prepared, they were put through a series of tests in the Project's laboratories, the tests being planned to show how treated soils would act under the conditions encountered at airport sites. Specimens failing any one test were not considered further. Results from the tests were analyzed and interpreted and conclusions reached about the value of the stabilizing admixtures.

Thirty-six Airport Sites. Under the direction of the CAA, the Project made surveys of thirty-six airport sites in various parts of the country to determine, from the standpoint of soils, the advantages and disadvantages of the different sites, to isolate the problems in construction that would have to be solved, and to make recommendations about the advisability of using the different sites. The primary interest was in locating sites on sands or gravels or in locating these materials so that they could be used for bases under running pavements. These studies were a part of the background of the large expansion in airport facilities occurring along with other wartime developments in aviation.

The contract for this work was received after the Project had surveyed a site upon which an airport was later built, its findings there having evidently established the usefulness of the contribution it could make.

Surveys were conducted by means of aerial photographs and the reports were checked later by inspection trips. Soil samples taken on location were sent to the Project's laboratories for analysis. A typical report on a site described the topographical features, identified the soils, located near-by deposits of granular materials, presented the photographic and other evidence for the conclusions reached, and, in short, gave the reasons why an airport should or should not be established on the site.

Load-carrying Capacities of Soils. Closely related to the program in which tests were made of soil-admixture combinations was another program, also conducted for the CAA, in which the load-carrying capacities of natural and reinforced subgrade soils were determined. In each program the ultimate objective was the efficient designing and building of airports and particularly runway strips, the immediate objectives being to extend the limits of the engineering knowledge of soils. The program related to load-carrying capacities was not simply a matter of running standard tests but of developing testing procedures and equipment and then determining data for certain natural and reinforced subgrade soils.

The practical need for this program was brought about in part by the unprecedented wheel loads of military aircraft. The performance of airport pavements under increased wartime traffic showed the necessity of making a scientific approach to the problem of determining when, and how much, subgrade reinforcement was needed in order that the pavement structure might have a definite load-carrying capacity. Previously the question of subgrade reinforcement had been settled on the basis of engineering experience and judgment. Among the questions to be answered were: When is subgrade reinforcing needed? How does load-carrying capacity vary with the seasonal moisture changes in the subgrade? When and where can a base design be duplicated?

Seventy-eight test sections were established on three plots in the vicinity of the Purdue Airport. Equipment was designed and built so that the load-carrying capacity of the different sections could be determined. Then measurements were made in dry weather and in wet weather, and the results showing the performance of different types of soils used in a variety of subgrade treatments were submitted to the CAA. How much this program contributed to improved construction of airports it is impossible to say. The data were not intended for a particular airport or a particular location but were expected to help provide a means by which airport design could be improved.

Alaskan Surveys. On August 1, 1945, a staff member of the Project left for Alaska to make soil studies by means of aerial photographs for the U. S. Army Engineer Office. His survey extended from Northway, near the Canadian border, to Nome and was completed in slightly less than six weeks. Though he discovered unusual soil conditions, he was able to show that aerial photography could be used in soil identification as successfully in Alaska as in other regions.

The problem of selecting suitable construction sites in Alaska was a bad one because of the presence of permafrost and ice beds beneath the tundra. Almost any disturbance of the surface caused this frozen subsoil or the ice beds to melt, and there usually followed a severe caving in of the ground. Roads, houses, any structures, caused this effect if they were not suitably located. Even an animal lying down and crushing the vegetation beneath him sufficiently altered the surface insulation to cause melting beneath the surface.

Plainly, if a way could be found by which areas of permafrost and ice beds could be quickly detected, then selection of good construction sites would be aided. Ground surveys were helpful but slow.

The staff member from the Project found that, from evidence in aerial photographs, areas of frozen ground could be defined, and, if ice beds existed, their extent and distance below the surface could be closely estimated.

New Construction, Wartime Traffic Speeds. The Photo-Velaxometer, an instrument developed by the Project for the measurement of traffic speeds, had a wartime usefulness in the determination of what new highways would have to be built. Where new construction was being considered, the instrument was used in conjunction with traffic counts for the making of accurate appraisals of traffic conditions. Thus essential needs could be distinguished from the unessential, and sound decisions could be made regarding the expenditure of labor and materials. In the vicinity of the Kingsbury Ordnance Plant, for instance, only those roads were built for which a proved need existed.

The Photo-Velaxometer had another wartime use when authorities wanted definite information about the effect of the traffic regulations instituted to save gasoline, oil, and tires. Project personnel, taking the instrument to various sections of the State, made studies to determine just how fast cars and trucks were going. The results were submitted to the proper authorities for such action as they deemed wise. Among the more interesting of the findings was the determination that average car speeds on Indiana's highways dropped from about 49 m.p.h. to about 42 during the first year of war and increased slightly during the second year.

Highway Pumping. Highway pumping became a serious problem on some Indiana highways, and on the highways of other states as well, with the arrival of unusually heavy traffic in war-congested districts. Pavements that would have withstood normal loads in normal times could not successfully carry such burdens as military tanks and trucks loaded with steel. The Project became aware of the problem early, and by means of studies and tests established the importance of sealing cracks and joints, located the highways on which trouble was occurring or might be expected, developed methods for taking at least temporary corrective measures, and proved that recommended construction designs would minimize pumping or prevent its occurrence. Probably most important of all, the Project discovered and focused attention on a serious threat to highway maintenance.

Research done by the Project disclosed that pumping results from a combination of soil, water, and traffic. Plastic clays and plastic silty-clay soils absorb water during wet seasons and are unable effectively to support the highway above them when a heavy load tends to thrust the pavement downward. A mixture of water and mud is forced from underneath the pavement through cracks and along the edges of the highway, sometimes being squirted as high as five feet into the air. As a result, a void is created under the pavement and subsequent traffic causes the pavement to break and settle. Motorists who have driven behind trucks during wet seasons have probably observed this pumping action.

A limited amount of pumping had occurred before the war, but most of the information about it had to be collected after essential heavy traffic had changed the problem from one of minor to one of major proportions. As an extreme example of the kind of heavy traffic meant, the passage of twelve tanks across a joint in a concrete pavement may be cited. The first three tanks caused little movement, but the joint was pumping severely under the last two or three.

Of the steps taken by the Project to obtain a complete understanding of the problem, only a few can be described here. The Project made surveys, prepared maps, collected soil samples and made laboratory tests on them, and correlated pertinent data. In one survey, made in the spring of 1942, each of 6662 joints in a stretch of highway was inspected. Observations revealed that, paradoxically, the damage decreased as traffic speed increased.

The conclusions pointed to the fact that the best way to avoid pumping was through scientific designing of new construction. The Project made known the areas in which pumping was a possibility and identified the various means by which it could be prevented.

War Products in the Materials-Testing Laboratory. As the name suggests, the Materials-Testing Laboratory is equipped and staffed for the giving of instruction and for the testing of such materials as steel, glass, concrete, and timber. The general objective of its test programs is to find what materials will be useful for what purposes and exactly how useful they will be. Inasmuch as many tests are carried to the extreme limit, when the material breaks or collapses, students for many years have referred to the Laboratory as the "Busting Lab."

During the war, in work related to military products, the Laboratory ran tests on ammunition, glass land mines, ammunition boxes, spot-welding, welding workmanship, and canvas for use in aviation.

An ordnance plant that manufactured ammunition for automatic guns asked the Laboratory's help on a materials problem. Standard hardness tests showed that metal being considered for crimping cartridge cases to projectiles was too soft for the work it was intended to do.

Continued quality-control tests were made on spring-lock washers used with the ammunition for different guns, including the trench mortar. These washers were required to maintain at an exact, specified value the tension between the explosive projectile tips and the projectiles themselves. Test data enabled the manufacturer to keep a close check on the quality of his product. When metals became critically scarce, the Laboratory worked on two problems that arose when attempts were made to substitute glass for metal in the construction of land mines. The first of these problems concerned the pressures that would have to be applied to the mines to detonate them. The second was that of keeping the mine effective when it was buried in wet ground or immersed in water.

For obvious reasons ammunition boxes had to be designed to deliver their contents in good shape to all parts of the world. Boxes of a type tested by the Laboratory were required not only to withstand rough treatment but also to remain sealed against moisture penetration. Several kinds of gasket material for use between the lid of the box and the box itself were investigated. These included two kinds of cork, natural and synthetic rubber, and fabrics impregnated with tar and asphalt. After a box had been fitted with one of these materials, it was exposed to the temperature variations it might encounter in service.

The Laboratory supplied test data on one hundred welded specimens made by spot-welding equipment being considered for certification by the American Air Forces. The problem with these specimens was to determine through shear tests whether the equipment could be depended on to make adequate welds between strips of sheet metal.

Welders who did certain jobs on aircraft and landing craft were required to be able to make welds to meet or exceed specifications of strength and uniformity. Seventy-nine of these welders, who worked for 10 companies in 7 Indiana cities, had 459 specimens of their welding sent to the Laboratory for testing and examination. Certification of ability to do skilled work could then be made on the basis of test data.

Extensive testing was done on canvas nose hangars, which are tent-like covers under which work on airplane engines can be done in areas where other shelter can not be secured. The canvas itself, the lacing, the seams, the grommets, the loop and snap connections, the rope, and the auger-type anchors—all were tested so that an accurate appraisal of their performance in service could be obtained.

THE SCHOOL OF CHEMICAL AND METALLURGICAL ENGINEERING

The School of Chemical and Metallurgical Engineering ran five research projects for government agencies during the war. Two of these, conducted for the National Defense Research Council, have been identified only as "The Making of War Chemicals" and the emergency making of methylamine hydrochloride. Three were sponsored by the War Production Board and are described in some detail.

The School also handled other research projects directly related to the war effort. In one of these, run co-operatively with Indiana industry, an attempt was made to find a substitute for galvanized pipe. A substitute was found, and then other substitutes; but each time there developed shortages in materials that prevented the substitutes from being used. In another, new pyridyl mercuric derivatives were discovered. These products were manufactured in fair-sized tonnages when they turned out to be useful in the prevention of molding, and consequently spoiling, of devices used in the Pacific war. They were used, for instance, to prevent decomposition through molding of fire-fighting foams used for the putting out of fires on warships.

Early in the war a number of unexpected and tragic failures of welded structures occurred. These led to an intensive investigation of welded metals and at Purdue were the subject of a study made in partial fulfillment of the requirements for the degree of Doctor of Philosophy. In the Purdue study alloy steel rods were used in order that comparisons might be drawn between them and plain carbon rods. Additional study was made of the cause of the minimum in impact strength at temperatures in the neighborhood of 1000° F.—a property characteristic of many ferrous metals.

In this research on welding it was found that alloy steel rods, by reason of good penetration characteristics, gave weld metals with excellent mechanical properties. Results were determined for different treatments of the steel, including prolonged annealing in wet hydrogen at 1300° F. and nitriding of hydrogen-annealed steel for 24 hours at 925° F. Test data showed that carbon is at least in part responsible for the marked increase in impact strength of carbon steels above 1000° F., and that nitrogen, though somewhat less effective, appears to alter the elevated-temperature characteristics in much the same way.

One important research project was interrupted by the war but is described here as representing a wartime change and a matter of general interest. At the present time many sections of the United States enjoy the luxury and convenience of natural gas. This fuel with 1000 B.T.U. per cubic foot is in many respects ideal for industrial and domestic use. Further, it has become a valuable chemical raw material since it may be used in the synthesis of many products. But supplies of this gas may not last indefinitely—it is more likely, in fact, that serious shortages may arise in 25 or 30 years.

To investigate the possibilities of manufacturing methane and ethane by the hydrogenation of coal, the School, with industrial sponsorship, embarked on a program of research. For more than two years, before the demands of the Armed Forces intervened, two full-time men were employed on this project and much pioneering and fundamental work was done. For this research bombs and apparatus for carrying out the synthesis at high temperatures and pressures were constructed. It was demonstrated that a gas of a little over 900 B.T.U. per cubic foot could be produced, and two bulletins were published having to do with this initial work. When the war intervened, the project was discontinued pending the outcome of governmental investigation along the same line. A special appropriation of Congress has placed at the disposal of the U. S. Bureau of Mines a sum of thirty million dollars with which research work can be completed and semi-commercial plants erected for the liquefaction and gasification of coal.

Recovery of Fats and Feeds. A rather startling raw material—garbage—was involved in an experimental program during the winter of 1943-1944. The research, sponsored by the War Production Board, was conducted so that an accurate evaluation could be made of a new process in garbage reduction. At the time, and even up to the present, critical shortages existed in the supply of fats, and some concern was being expressed over the possibility of a feed shortage.

Described in simple terms, the process involved grinding the garbage, using a hot solvent for the extraction of fats and water, removing the feeds and fats from a continuous treating system, returning the solvent for re-use, and drying the feeds. A critical point concerned the action of the garbage when it was mixed with the solvent and agitated. It was necessary that the garbage become friable, like corn meal, and stay friable throughout the process so that it would not collect in pipes and on heating surfaces in sticky, unworkable masses. It was also necessary that almost all the solvent be recovered, not only from the standpoint of cost but also from that of feed contamination, and that harmful materials such as sand, glass, and bones be removed from the feeds.

Equipment of laboratory size was designed and constructed in the basement of the Chemical and Metallurgical Engineering Building. Preliminary test runs made with small quantities of garbage gave information about the rate of cooking, the separation of treated from untreated garbage, the effectiveness of different solvents, the fat content of solvents within the treating system, and the proper ratio of solvent to garbage. Two operational "bugs" were discovered and corrected.

Test runs varied in length from three hours to 60 hours and in amount of garbage treated from 40 pounds to 1225 pounds. The 60-hour test run showed what might be expected of the process in continuous operation. Per ton of wet garbage treated, more than 430 pounds of feeds and more than 84 pounds of fats of good quality were recovered. Translated into the larger terms of a plant handling many tons of wet garbage per day, these quantities meant the salvage of substantial amounts of scarce products. Cost estimates based upon power and steam consumption and the amount of labor required showed that a full-scale plant was economically feasible.

Lead as a Substitute for Zinc and Tin. The use of lead as a protective coating for iron and steel has been called a hardy perennial among metallurgical problems. In the four decades preceding the war, sporadic attempts were made to use the metal as a substitute for zinc and tin, and some lead-coated products were made that showed unusual resistance to corrosion. But nothing much needed to be done about using lead as a coating material so long as tin was available and zinc was both available and cheap. Galvanized sheet (steel coated with zinc), terne plate (steel coated with a lead-tin alloy), and other coated products were, in general, adequate. The necessity for vigorous experimental work on lead arose only when the Japanese seized the tin mines in Malaya and the Dutch East Indies.

Under the auspices of the War Production Board, the School of Chemical and Metallurgical Engineering on September 1, 1942, began a research program designed to reveal to what extent lead might be used as a coating material, what possibilities lay in the use of lead alloys, and how a lead-coating process could be operated in industry.

A dipping machine of laboratory size was designed and constructed. Similar to machines used in galvanizing, it provided means by which strips of sheet metal could be dipped into a bath of molten lead or lead alloy, held immersed over a specified time, and removed with close control of exit conditions.

Then began a long series of experiments in which the variables affecting the coatings were closely controlled. Zinc, tellurium, arsenic, and antimony, separately and in combination, were tried as alloying materials. Also varied were methods of pickling, dipping temperatures, and cooling rates. Since alloys containing zinc showed exceptional merit, special attention was given to finding which percentage was best and to holding constant the amount of zinc in the dipping bath. The worth of the different coatings was determined in a series of tests.

The major achievement was the obtaining of proof that an excellent coating could be made with an alloy containing lead and a small percentage of zinc. This coating had a corrosion resistance greater than that of galvanized sheet and equal to that of terne plate. It had excellent adherence to the base metal because of a chemical bonding with the metal and superior bending properties. It soldered readily and in the coating process could be made to produce a spangle which in part overcame its unattractive appearance. Its principal disadvantage was its softness, which limited its potential usefulness to applications in which it would not be subject to wear or abrasion. There was every reason to believe, however, that in the many applications for which it was suited it would prove a good substitute for war-scarce metals.

Cresol from Non-Strategic Materials. Graduate students under professional direction contributed to research in which a way was found for making cresol from a non-strategic material. This research, sponsored by the War Production Board, was conducted as a safety measure when there was a strong probability that imports might not be sufficient to supplement the normal domestic production and supply the demand. Cresol was important as one of the constituents for the making of resins required in the war effort—it was used, for instance, in the plastic lining for military helmets.

The research lasted for approximately twenty months and included investigations of a number of raw materials. The solution was finally based upon making cresol from toluene, a material available in sufficient tonnage. High-pressure steel equipment was used in which chlorinated toluene derivatives were reacted with aqueous caustic soda. Details of this research were approved for publication in *Industrial and Engineering Chemistry.*

THE SCHOOL OF ELECTRICAL ENGINEERING

Steel Conductors. Long-term co-operative research on steel conductors for telephone and power lines was begun in 1930 and is still being continued. The object has been to improve these conductors so that they can more successfully compete with conductors of copper and aluminum. In normal times they are used principally in rural areas where distances are great and power loads are small. During the war, in part because of the Purdue research, they were available for wider use when copper and aluminum became critical materials. Thus a peacetime project was found to have a value in the strengthening of the wartime economy.

Compared to copper and aluminum conductors, steel conductors have the superiority of much greater tensile strength. This allows the conductors to carry their own weight between poles set far apart and so makes for economies in construction. But the resistance of steel to the passage of electricity is approximately six times that of copper, and the loss of power in the transmission lines is correspondingly greater. An additional loss is caused by the magnetizing effect of the electricity on the steel conductors. This is termed the "iron loss" and is of consequence in the transmission of alternating current. Of critical importance in the investigation is the fact that the electrical characteristics of steel conductors are strongly affected by the presence of slight impurities in the steel and by such processing operations as quenching, annealing, and galvanizing.

Graduates who left the School of Electrical Engineering in the 1930's will probably remember when the testing apparatus and conductors were set up in one of the hallways of the building. Nowadays the testing is done in the High-Voltage Laboratory. Test lines under severe tension can be set up here and the temperature along the lines can be closely controlled. Students are employed in their spare time to help in the testing and to plot curves. They receive, besides their wages, training in the ways of industrial testing.

One large use of steel conductors during the war was in the construction of power lines to pumping stations along the Big Inch Pipe Line. The electrical characteristics of these conductors were determined by the School of Electrical Engineering and the mechanical characteristics by the Materials-Testing Laboratory.

Precipitation Static. The problem caused by the interference of precipitation static with clear radio reception aboard aircraft received a good deal of attention during the war, and at Purdue was the subject of a comprehensive investigation conducted for Wright Field. This research received assistance from civilian and military agencies and was related to similar programs conducted elsewhere. A chief reason why Purdue won its assignment to the problem was its previous good work on precipitation static. In the 1930's a staff member, on loan to an aviation company, contributed to the development of static-eliminating devices that are still being used, and tests made here in 1938 had shown that use of camouflaging paints and lacquers on military aircraft might greatly complicate the static problem because of the high charging rates of these materials.

In the wartime program the following major results were achieved:

1. Development of laboratory methods and equipment for determining charging characteristics of aircraft coatings under bombardment of snow and frost crystals.
2. Completion of approximately 1500 tests involving some fifteen to twenty thousand readings on 450 samples, the data contributing to a good understanding of the problem of precipitation static.
3. Determination of mathematical means of finding the effect on charging rate of velocity, altitude, relative humidity, temperature, and other factors.
4. Discovery of materials that, when added to lacquers and paints used as surface coatings, caused charging rates to be very low.

Precipitation static has been known to become so loud as to cause a complete blanketing of radio reception aboard aircraft for periods as long as several hours. It appears when a plane becomes electrostatically charged during flights through rain, snow, hail, ice crystals, and dust clouds—in other words, when visibility is poor and the pilot has greatest need of radio directions. Sparks jumping to the plane itself from insulated surfaces, such as windshields and de-icers, can cause some of the static; but corona discharge from the plane to the surrounding air—the same discharge known to sailors as St. Elmo's fire—causes the most serious interference, the corona discharge being heard in the headphones as a crying, frying, or musical noise above which the radio signal cannot be distinguished.

One of Purdue's contributions toward solution of the problem has been the discovery that snow and ice crystals hitting against the plane and sliding across its surfaces are chief offenders in the creation of static.

If one wonders how and why the plane becomes charged, he may recall that phenomena of the same kind are evident in everyday life. Persons walking or even sitting in dry rooms may become charged and later startled when a spark jumps with a snapping noise to another person or to an object. Gasoline trucks are wisely required to dangle chains behind them so that the charges they collect may safely be carried to the ground. Even such a simple action as striking a hammer against a board is accompanied by a small electrical effect.

Two general methods have been found for eliminating or reducing this static. One is that of preventing the plane from becoming charged, the other that of providing a means by which the charge may be dispersed through what is known as a "soft corona."

Purdue's part in the solution of the problem was concerned with the reduction of the ability of aircraft to collect electrostatic charges. Before headway could be made, the problem had to be brought from the field—or, more accurately, from altitudes as high as the substratosphere—to the laboratory where it could be seen in all its ramifications. Data were needed on the many variables that affect charging rates and especially on surface coatings, the type of coating having been shown to be a principal factor affecting the rate.

Laboratory equipment was designed and built in which the variables could be controlled. Through use of this equipment, a sample strip of metal coated with a paint or a lacquer could be bombarded with snow crystals traveling at a known rate, and the charge left on the sample could be measured. Improved equipment was built later after the importance of the angle at which the crystals struck the plane was established. Snow for the tests was gathered on the outskirts of West Lafayette where it was free from contamination. Many of the samples submitted to bombardment were prepared by a member of the Department of Chemistry.

The statement that 450 samples were tested hardly does more than suggest the scope of the program. It does not account for the wide ranges over which the samples were tested, the precautions taken to insure the collection of good data, the hours spent by personnel in sub-zero temperatures, the formulation of difficult mathematical relationships, or the patience and skill required in the preparation of the samples. The program was large in scope and large in fulfillment. When it ended, precipitation static had not been completely conquered, but the problem had been rather thoroughly explored and surface coatings had been found that gave very low charging rates.

It was not enough that the surface coating should resist the taking of a charge. The coating had to maintain the low-charging effect under all conditions of normal flight operation. Further, the coating had to be durable, smooth enough to prevent excessive drag on the plane, and light enough not to add excessive weight. Finding a coating that would have a low charging rate was comparatively easy; finding one that would meet other requirements, comparatively hard.

For general interest, a phenomena deserves to be mentioned that was observed when the test equipment was taken to Wright Field for tests in the Stratosphere Chamber of the Aircraft Radio Laboratory. Not being certain that snow would be available at Wright Field, the men who made the trip took a supply with them. Ironically, on the night of their arrival a heavy snowfall occurred. They made their tests the next day—at temperatures as low as forty degrees below zero—and, their supply running short, switched to Wright Field snow. A startling discrepancy was immediately evident. Whereas West Lafayette snow caused the samples to take a negative charge, Wright Field snow under identical test conditions caused the samples to take a positive charge. At the time this was roughly equivalent to finding water that was not wet or that would run uphill. Check tests showed that the results were valid, and explanations were found that accounted for the discrepancy. Besides having some general interest, the incident furnishes a good example of the baffling problems encountered during the program.

Future work probably will have to be done on precipitation static. The arrival of jet planes with their terrific speeds may mean such an increase in charging rates that still other methods for reducing the rates may have to be found. Frequency modulation does not seem to be the answer to new problems that may arise, but there is at least a chance that some of the developments of radar may be of use. In any event, the understanding of precipitation static reached at Purdue during the war years, since it is based on a large body of scientific knowledge, will have its continuing applications.

Spark Gaps and Magneto Testing. In a project that gave help to Wright Field in the testing and development of aviation magnetos, research specialists of the Engineering Experiment Station, Electrical Division:

1. Prepared a bibliography of the technical literature on spark gaps.
2. Tested many types of existing spark gaps, determined their limitations in magneto testing, and collected data for the development of an improved spark gap.
3. Developed an improved spark gap that gave better service than previous gaps.
4. Tested and made appraisals of electrical equipment purchased for testing work on magnetos at Wright Field.

During the preparation of the bibliography, a research man practically lived in the Purdue Library while he searched out the pertinent titles and wrote brief descriptions of many of the articles and books. The completed bibliography filled eighty-nine pages and was indexed according to subject. Because of it, technical men had a means of quickly learning what information about spark gaps had been published and where it had been published.

In the research on existing spark gaps, the objective was to learn how dependable the gaps were in the testing of aviation magnetos and to collect data that could be used in the design of an improved gap. Other methods of testing magnetos required time, expensive equipment, and considerable technical ability. By the spark-gap method, if it could be made reliable, the testing would become a routine task that could be quickly done. Magnetos used in the tests were sent from Wright Field so that actual conditions could be simulated. Photographic recordings of cathode-ray oscillograms of gap operation had a chief role in the investigations. Statistical methods were used in the analysis of the data.

A bothersome problem in the development of an improved gap was the high rate of sparking at which the gaps were required to operate. With sparks jumping the gap many times each second, varying residual effect at the electrodes tended to cause each spark to be affected by conditions resulting from the passage of the previous spark. This effect had to be eliminated if a gap were to be designed that would always spark over at the same voltage and be consistent in operation from day to day.

As in all fundamental research, the investigation moved into any territory that looked promising. Various types of gaps between various metals were tested, as were enclosed gaps sparking over through inert gases. By the fall of 1942, sufficient data had been collected to show that elaborateness of design was neither feasible nor justified, since a gap suitable for Wright Field's purposes could be developed through modifications of an existing type of gap. The improved gap was provided with a new type of "teaser" electrode that assured a continuous and effective teasing action and with an increased area of sparking that prolonged the life of the gap surfaces.

The instruments tested and appraised for Wright Field were an electrostatic voltmeter, a cathode-ray oscillograph, a calibrated standard ball gap, and four crest voltmeters of the rectifier type. Wright Field wanted to know how accurate and adaptable these instruments would be in measuring the crest value of the magneto voltage wave. Tests were run at different magneto voltages, at different rates of sparking, and with different types of voltage waves. Calibration curves with correction factors were drawn, and a critical analysis of the characteristics of each instrument was prepared to indicate its suitability for magneto testing.

Four Special Research Projects. Research conducted in the Electrical Division of the Engineering Experiment

Station under contracts with the Office of Scientific Research and Development was done in the four projects described, in a non-technical way, in the four subsections that follow: An Oscillograph for Aberdeen, Television as a War Weapon, A Standard Noise Generator, and Improved Radio Control Equipment for Target Airplanes.*

An Oscillograph for Aberdeen. It is hard to give proper credit for the construction of a four-unit, cathode-ray oscillograph built for the Aberdeen Proving Ground. The instrument was too complicated to be described except by an expert, and then mostly in terms of diagrams and drawings. Its complexities would mean as little to the layman as do the more abtruse explanations of nuclear physics. Possibly some idea of its significance may be grasped if it is simply stated that the instrument was possibly the largest and most versatile drum-camera oscillograph ever built and that the work done by the research men was described as "a wonderful job."

An oscillograph is an electronic instrument that will give a visual picture of what is going on in an electric circuit. It will show the wave shape of the current or the voltage and will do this at slow, medium, or fast speeds, according to the purpose for which it was made. Through its pictures of events in an electric circuit, research men can learn how well equipment is working or why the equipment is not working at all. It has thousands of applications, one of the newest having been in the development of radar.

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*The work on the oscillograph, on television, and on improved radio control equipment was done under contracts between the Purdue Research Foundation and the Office of Scientific Research and Development. Construction of the standard noise generator was begun under a contract between the Purdue Research Foundation and the Office of Scientific Research and Development and continued under a contract with the Army Air Corps. The research itself was done by the Engineering Experiment Station, Electrical Division.

The four-unit oscillograph built for Aberdeen was essentially four oscillographs synchronized to respond simultaneously to signals from a central control panel. The construction of each unit was a job in itself, but the synchronization of the four units was a major problem. Except the framework, all of the building was done at Purdue. The framework was furnished by Princeton University.

The Engineering Experiment Station, Electrical Division, was qualified to build this special oscillograph because it had had general experience in electronics and also because techniques learned in long-term research in television were applicable. The contract was signed on April 13, 1943; but so much had to be done that not until almost two years later, on April 9, 1945, could the finished instrument be delivered. The new instrument was expected to allow a saving in time and ammunition in test firings and to add to the significance of data collected.

All principal specifications were met. New electrical circuit arrangements were made, and special devices were designed and built for the handling of the control problem. As the work developed, certain changes were suggested upon which mutual agreement was reached. But between the beginning and the ending of the project a great deal of difficult and creative technical work had to be done. Purdue can be proud that it had the facilities and the technical brains necessary for the successful completion of this war research.

Television as a War Weapon. Shortly after Pearl Harbor, evidently before the effectiveness of radar could be predicted with certainty, a kind of insurance against possible failure in radar was secured through research directed at learning how well the methods and equipment of television could be used in the directing of anti-aircraft fire. This plan of using more than one method to achieve the same end was probably applied more widely than is generally realized. At a time when failure could not be tolerated, there was good reason to explore all possibilities so that, if research in one direction led nowhere, then research in one or more other directions might find the right answers. Further, there was no harm in knowing how far television could be pushed as a war weapon.

Purdue was eminently fitted for this task. Since 1929 basic research in television had been conducted here under commercial sponsorship, and valuable discoveries had been made that are being used in present television and that almost certainly will be used far more widely in the future. Purdue had its own television station, experience, equipment, and a staff ready to tackle the problem. Assignment to Purdue of the required developmental research was a logical wartime outgrowth of a peacetime activity.

Essentially the objective was that of building television apparatus that would track aircraft across the sky and make possible accurate anti-aircraft fire. The developmental work was a combination of the electrical and the mechanical. A large telescope was mounted in such a way that two operators could control the direction in which it pointed. Mounted on the telescope was a television system in miniature. Coordinating circuits took the output from the system and applied it to instruments that made corrections in aiming devices, enabling anti-aircraft guns to be aimed at the true position of enemy planes. The completed apparatus was to make adjustments for manual errors in tracking. How all this could be done must forever remain a mystery to everyone except experts in television.

Such terms as *iconoscope, autosyn,* and *orthicon* are only a beginning—the fundamentals taught in television's first grade, so to speak. Putting to work the instruments they represent, in systems that would get results, was a matter of advancing from the difficult to the seemingly fabulous,

Suffice it to say that, if possible, the television equipment was to be reliable, simple to operate and service, compact, and light in weight, and was to be capable of sweeping across all parts of the visible sky and locating the true position of any aircraft that appeared therein.

Toward the end of 1942 one of the biggest disappointments that can come to research men occurred. The project was cancelled, possibly because radar had by that date proved itself. The research men were convinced that, up to a point, television methods and equipment could be used in the directing of anti-aircraft fire even though they were not given time in which to make a practical demonstration. But they also recognized the inherent limitations of their apparatus with regard to simplicity, weather, time of day, and distance of coverage, and their regret at not being allowed to finish their work could be forgotten in the rush of other projects assigned to them.

A Standard Noise Generator. There was wide interest in the design and construction of a standard noise generator to be used in acceptance tests of radio equipment, and in January, 1945, research men in the Engineering Experiment Station, Electrical Division, began the task of building one. The noise generator was completed early in 1946, and another like it was to be built so that two would be available as models. Since there was wide interest in the instrument, 150 copies of the report describing it were to be prepared, each report to include a manual of instruction detailing operational procedure.

The noise generator was needed for the running of tests on radio equipment for such installations as those on tanks and airplanes. In such installations the nearness of motors, relays, switches, and other noise sources tended to cause a high noise level over the whole frequency band. Specifications required that the noise should not exceed a certain amount, and it was necessary that enforcement of specifications be done fairly.

For reasons that would be understood by radio engineers, noise measurements are difficult to make. The noise generator that would give satisfaction would have to deliver checkable results no matter where or when it was used. The Purdue research men, however, had some ideas which they wanted to apply, and the result was a generator unlike any earlier instrument made for the same purpose. It covered an extremely wide frequency band and was believed to be capable of giving valuable help in the acceptance tests.

Improved Radio Control Equipment for Target Airplanes. Research was begun in November, 1941, on the development of improved radio-control equipment for target airplanes, and the final report on technical progress was submitted on December 1, 1942. Members of NDRC made several visits to the campus to discuss details and to witness demonstrations of the two improved control systems developed. Personnel from the Aircraft Radio Laboratory at Wright Field also witnessed one of the demonstrations.

A receiver was wanted that would control the movement of the rudder and the elevators of a target airplane in response to radio signals transmitted from the ground. The receiver was to be light in weight and to be capable of giving reliable performance over relatively long periods of time. The starting place in the research was a method of control invented by a staff member. Through this method, a small electric motor operated the rudder and the elevators, reversing its direction of rotation as the frequency of the transmitting signal was varied.

Study of the basic method showed how the research should proceed and identified some of the technical problems to be solved. A new circuit was developed in which special devices meeting rigid requirements were incorporated. Plans to build complicated transmitting and receiving equipment could then be abandoned. The new circuit was applied in an improved receiver, which was installed in a Type A-2 target airplane supplied by the Materials Division of the Army Air Corps. Though in general the receiver operated as expected, success was limited by vibration and ignition noise from the engine of the target plane.

Further research produced a second new circuit that gave a highly satisfactory solution of the problem. A small working model was built and demonstrated. It featured a reduction in the number of tubes, relays, and associated parts and reduced current consumption. Along with the simplicity went a much-wanted advance in the closeness of the control under which the target plane could be held. Strenuous laboratory tests revealed no defects in the new control system; but with time getting short, full confirmation of laboratory results could not be made in field tests. When the final report was submitted, the belief was expressed that additional development of mechanical details was warranted and that a thoroughly dependable, light-weight, and easily directed control system based on the second circuit could be made available.

THE SCHOOL OF MECHANICAL AND AERONAUTICAL ENGINEERING

On July 1, 1945, the instruction and research in aeronautics carried on in the School of Mechanical and Aeronautical Engineering were transferred to the new School of Aeronautics. The educational program announced for the new school was divided into two major fields, aeronautical engineering and air transportation. In the fall the overwhelming number of applicants for admission to the new curricula attested to the popularity and timeliness of this wartime move to prepare Purdue for an important role in what well may be an Air Age.

During the war a research project in aeronautics dealt with tests of celluloid cylinders to determine the ultimate strength of interacting members under combined compression, bending, and torsional loadings. It was conducted for the National Advisory Committee for Aeronautics. In addition to research described in pages that follow, the School, working with the School of Civil Engineering, conducted a substantial program in artillery research.

High-Temperature Steam. Like other technical matters, the research conducted on high-temperature steam cannot be well described in everyday terms. Its objective, broadly speaking, was improved efficiency in the operation of power plants. Its means was a series of exhaustive tests on alloy steels at temperatures as high as 1800° F. What was wanted was an understanding of how the alloy steels would perform if exposed to high-temperature steam under conditions comparable to actual conditions. This was background research of the kind that lays the foundation for technical advances, though to the layman the results were only a mass of tables and curves accompanied by abstruse discussion and conclusions. A long-term project begun in 1934, it became war research and was sponsored by the United States Navy in connection with the design of boilers and turbines for the power plants of large ships.

A major part of the investigation as a whole was concerned with the corrosive action of high-temperature steam. Low-carbon steel, it had been known for years, suffered pronounced corrosion at temperatures well below those at which boilers could be operated at higher efficiency. Accordingly, alloying elements were tried, these including molybdenum, chromium, silicon, and aluminum. Test results for unstressed specimens included data on the type of scale formed, the depth of scale layer formed at times of 500 to 2000 hours, and the effect of time and temperature on the depth of corrosion.

Another major part of the investigation dealt with the behavior of alloy steels under stress in an atmosphere of high-temperature steam. Information of a technical sort was obtained. For each of nine alloys, for example, a curve was prepared of rupture strength vs. time to rupture for times up to 7700 hours, this relationship resulting in a straight line when plotted on log-log coordinates.

The results from this investigation gave definite evidence of the type of service to be expected of the alloy steels when they were considered for use, in the stressed or unstressed condition, in the building of boilers and turbines.

Research for the Army Ordnance Department. In the early part of January, 1942, Purdue University notified the Army Ordnance Department that facilities and staff were available in the Engineering Experiment Station for research in ordnance. A conference at the War Department followed and, as a result of decisions reached, the University initiated a program in small-arms research that lasted throughout the war and that is still being continued. This program, beginning with only two full-time men and one quarter-time man, was expanded many times and soon became one of the University's major undertakings. Its researches were pushed with vigor, the test firings on occasion being conducted late into the night, in fair weather and foul; and personnel were able to show that they possessed not only necessary engineering ability but the stamina and willingness to handle their assignments throughout sixteen- and eighteen-hour working days. On July 20, 1944, in recognition of the value of the small-arms program, the University was authorized to receive the Ordnance Distinguished Service Award.

In connection with the Award, Major General L. H. Campbell, Jr., Chief of Ordnance, in a letter to President Elliott, wrote in part as follows:

> To attest the appreciation of the Department for the splendid services of your University, I wish to present to the University the Ordnance Distinguished Service Award. It is a diploma bearing the traditional seal of the Department and is awarded in recognition of scientific and engineering achievement.

The significance of the Ordnance Distinguished Service award, as stated by the Chief of Ordnance, is presented in the following:

> The Ordnance Distinguished Service Award is presented by the Ordnance Department in tribute to those educational, scientific, and industrial institutions of our country that are contributing in a very signal way to the winning of the war. To Purdue University the Ordnance Department is deeply indebted for services of outstanding quality.

The Award was presented on September 14, 1944, by Brigadier General A. B. Quinton, Jr., Chief, Detroit Ordnance District, in ceremonies in the Hall of Music, President Elliott presiding. In the speech of acceptance Dean A. A. Potter said in part:

> It is most gratifying to Purdue University to have its research contribution in the field of ordnance recognized by the War Department. This award will stimulate teachers and our students in their scientific and engineering research accomplishments, so that Purdue University will have new knowledge available for the benefit of this great nation to meet emergencies and to build for better and happier living in a world at peace.

In December, 1945, a second honor was received when the staff member in charge of the research in small arms received the War Department Certificate of Appreciation for co-operation and assistance in the Ordnance Munitions Program during the emergency.

Among the problems encountered in the research on small arms were those in the list that follows:

1. Analysis of the motion of components of automatic weapons by high-speed motion pictures at rates up to 8,000 frames a second, displacement cameras, oscillograms, and special apparatus. By means of the techniques developed, it was possible to observe by high-speed photographs, springs, accelerators, bolts, and other parts during deceleration and acceleration at extremely high rates.
2. A basic study, theoretical and experimental, of the transient-state heat flow through gun barrels. This is one of the most difficult problems in the field of heat conduction because of the fact that extremely short time intervals are involved, ranging as low as one millisecond.
3. A study of the ways for cooling barrels of automatic weapons during long bursts of firing. The cooling of barrels has been a problem confronting the designer of weapons for well over a century. The magnitude of the problem is obvious when one considers that during the firing of long bursts external temperatures may reach 1900° F.
4. Erosion tests and studies of the life of gun barrels under various rates of firing. Erosion in gun barrels

is a serious problem complicated by such variables as type of powder, shape and weight of barrel, and rate of fire.

5. The design of an instrument for measuring very rapid temperature changes in gun tubes. For many years the problem of measuring rapidly changing temperatures has confronted the engineer in heat-transfer work. Instruments that have been available are in general not suited for measuring temperature changes which occur in the order of ten milliseconds. The successful design of an instrument for measuring rapid temperature changes will find wide application in many problems, as in the study of grain size in rapid-quenching operations.
6. The development of a projectile velocity recorder for burst fire. Up to the time of World War II instruments were not available for measuring the velocity of individual projectiles in burst fire. With the introduction of automatic weapons having high cyclic rates the need for knowing the velocity of every projectile in a continuous burst of fire became important. Hence, extensive research work was done on this problem at Purdue and other institutions.
7. Performance testing of new experimental automatic weapons.
8. Special tests of experimental ammunition.
9. Studies concerning the phenomena associated with smoke and flash from automatic weapons.
10. Special tests covering the operating performance of auxiliary gun components, such as feed chutes and electric loaders. Before such devices are manufactured, it is necessary to conduct extensive preliminary tests to determine their reliability.
11. A fundamental study of the momentum and energy balances in existing automatic weapons. In order to make an analytical design of an automatic weapon, it is necessary to have available a large amount of fundamental data concerning the momentum, velocity, acceleration, and energy of various components.
12. A study covering the influence of such factors as temperature, pressure, and shape on the design of gun tubes.
13. A fundamental study of desirable operating characteristics of machine-gun mounts.
14. The translation and analysis of captured enemy data dealing with all phases of automatic weapon research.

15. Assistance to industrial organizations in the problems that arose in producing the industrial arm from the experimental model.

The Firing Ranges. The first Purdue firing range, Range A, was in an abandoned gravel pit and walnut grove on the Edgewood Farm, just west of the Purdue Airport and about two miles from the Heat Transfer Laboratory. By later standards it was judged to be rather primitive. The gun mount, constructed principally of pieces of structural steel held in place by sand bags, was exposed to the weather, and batteries were the only source of electricity. Firing was directed into a hole dug into one side of the gravel pit. Apparatus, guns, and ammunition were transported to the site each day a test firing was held. Cattle sometimes had to be herded from the gravel pit before operations could begin, and personnel will long remember the showers of walnuts that fell on them from the trees overhead when concussion from the guns shook the nuts loose. The range, nevertheless, served its purpose until late October, 1942.

The second Purdue firing range was under the West Stands of the Ross-Ade Stadium and was used in October and November, 1942, for a series of urgent tests. On completion of these tests, apparatus that had been designed and tested was shipped to Aberdeen, and plans were prepared for the construction of a new range for the experimental work to follow.

Range 1, actually the third Purdue range, was established in the small area partly enclosed by the Mechanical Engineering Building, the Draft Gear Laboratory, and the Heat Transfer Laboratory. A frame firing house was constructed here as well as a butt of reinforced concrete, sand, and sand bags into which projectiles were fired. This range had several advantages over earlier ranges, including nearness to headquarters in the Heat Transfer Laboratory; but since it was in the center of the campus, firing was restricted to the hours between 4 P.M. and 10 P.M.

Range 2 was the first range built on the hillside to the north of the men's tennis courts where the present permanent ranges are situated. Like earlier ranges, it was essentially an open-air range, and during the bad winter months snow storms and the like often interfered with test firings. One gun mount was established in a firing shed and another between the shed and the butt, the butt being dug into the side of the hill adjacent to the golf course. In February, 1945, the firing house burned and Range 2 was abandoned. By this time, however, Range 3, Purdue's first enclosed range, had been in operation for some months.

Range 3 was constructed early in 1944 when a large expansion in the research program could be foreseen. Still in operation, it consists essentially of an ammunition vault, a firing room, a firing tunnel with observation rooms attached, and a butt. To personnel who had been with the program from its early days in the gravel pit and walnut grove, Range 3 was a great advance over earlier ranges. It could be operated without regard to weather conditions, and the enclosed tunnel permitted permanent installation of testing equipment. This range was built in the remarkably fast time of twenty-two working days.

Ranges 4 and 5 are similar in design to Range 3, each being enclosed and of permanent construction. Range 4 was built primarily for the study of gun mechanisms.

Range 5, the latest of Purdue's seven ranges, is the largest enclosed artillery range in the United States. A feature of Range 5 is the box-like shell of armor plate used as the interior lining of the butt. This shell was welded together in Hammond and transported to the campus by truck. So substantial is the butt that an armor-piercing projectile from a 6-inch gun could be fired into it with a safety factor of two.

It is noteworthy that, though there were many opportunities for accidents in the operation of the ranges, no accident occurred that resulted in serious or permanent injury to personnel. Also noteworthy was the number of rounds of ammunition expended in the test firings—an estimated 1,000,000.

In the research on small arms Purdue University was able to provide a direct example of the manner in which its facilities and staff contributed to the war effort. That its wholehearted co-operation was appreciated was made evident by the awards received and by the many additions to the scope of the research to be done. From small beginnings the program grew to the point at which some 50 persons were employed in it, the University thus becoming a sizable cog in the machinery through which the Ordnance Department developed weapons for World War II.

Research for the Army Air Forces. In June, 1941, the School of Mechanical Engineering, through the Engineering Experiment Station, undertook an extensive co-operative research project for the Army Air Forces at Wright Field. This program was active throughout the war period, and certain phases of the work have recently been extended for another period of two years. The program has been concerned with the solution of numerous fundamental problems associated with the development of the aircraft power plant. These problems are discussed briefly in the following paragraphs:

A study was made of heat transmission in aircraft radiators and the power loss due to the frictional resistance caused by the flow of air through radiators. A large amount of data furnished by the Army Air Forces was analyzed in order to develop optimum design conditions for aircraft radiators from the standpoint of high heat-transfer rates and low power loss.

Detailed force and power analyses of various combinations of hydraulic couplings and gear transmissions were made for the purpose of discovering various types of variable-speed, high-efficiency supercharger drives that merited further development.

A theoretical analysis and an experimental investigation were made of the measurement of the visibility of exhaust gases and exhaust pipes of aircraft engines. Ways and means were considered for reducing the visibility so that the aircraft would present a poorer target at night.

An extensive mathematical and experimental analysis was made of resonance and interference in multi-cylinder engine manifolds. Investigations have shown that the volumetric efficiency of an internal-combustion engine and the maximum power output could be increased substantially by designing the intake manifold so as to set up a resonant condition under which a surge pressure considerably above atmospheric pressure would exist in the manifold just before closing of the intake valve. This resonant condition has the effect of supercharging the engine. Exhaust manifolds can also be "tuned" to produce a minimum pressure just before the closing of the exhaust valve in order to bring about maximum discharge of burned gases from the cylinder. The various factors that influence the design of the intake and exhaust manifolds and contribute to desirable resonance were investigated both analytically and experimentally.

A theoretical and experimental study was made of some jet propulsion devices. The fundamental theory was examined and an investigation was made of thrust augmenters for use in connection with jet propulsion devices.

In co-operation with the Department of Chemistry, an extensive study was made of the production of polyfluoro organic compounds and their evaluation as suitable fluids for aircraft engine coolants.

A study was made of the performance of aircraft vacuum pumps as influenced by altitude, and methods of analysis were developed that made it possible to correlate the performance of vacuum pumps under high altitude conditions with the performance as determined by low-altitude tests.

A fundamental investigation is being made of the flow of air through fan lattices for fans of the axial-flow type. This includes a systematic study of the flow of air through practically all possible combinations of blade shapes, spacings, and angles. The results are particularly applicable to the design of high-speed wind tunnel fans, high-capacity cooling fans, and axial flow compressors.

Chapter IV

AGRICULTURE

INDIANA FARMERS RESPONDED SUPERLATIVELY TO THE call for maximum food production "to win the war and write the peace." Adequate proof is found in the rising production figures over the war years. For a specimen year, 1944, the reports show that on Indiana farms a volume of production 49 per cent greater than that for 1939 was achieved. This increase was significantly larger than the 37 per cent increase reported for the nation as a whole and demonstrates how successfully the great fertile areas of Indiana—a part of one of only three such areas in the world—were made to produce in support of the cause of democracy. In approximate figures, cash receipts for Indiana crops and livestock were $385 million in 1941, $539 million in 1942, $646 million in 1943, $671 million in 1944, and $684 million in 1945.

This increase in food production was reached through long hours of hard labor, by the efficient use of farm machinery, and by the application of up-to-date agricultural science. To the farmers and their families must go the credit for the successful mastering of wartime difficulties that on many occasions must have seemed insuperable. There were shortages of labor, of machinery, of items too numerous to mention here; and at least two of the growing seasons were accompanied by stretches of unfavorable weather. Yet when the crops and the livestock were marketed, it was found that "impossible" production goals

Beef Cattle on Pasture. Research in the Purdue Agricultural Experiment Station helped Indiana farmers increase the yields of crops used for forage.

Food for the State, the Nation, and the World. Hybrid corn varieties adapted to Indiana needs, as well as much fundamental research, helped Indiana farmers meet difficult production goals.

View of Range 3 from the West End.

Electricians' Mates at Morning Calisthenics. About 6,000 were trained in the U. S. Naval Training School, Electrical, at Purdue.

had been met or exceeded and that Indiana farmers had done all that was asked of them, and more.

It is important to note that a 49 per cent increase in agricultural production cannot be viewed in the same light as a similar increase in industrial production. When more airplanes were wanted, and more tanks and more ammunition, productive capacity could be enlarged through the building of new factories. This, in the main, could not be done on the farms. Livestock production is governed by biological laws not in man's power to change. The number of acres available for cultivation can be increased but not in such proportions as the number of factories. Farmers, then, were severely limited by restrictions inherent in the kind of work they did, and there were authorities who believed strongly that at best only a normal rate of production could be maintained, their contention being that farms were already worked on a 24-hour basis. Thus the production achieved must be viewed as largely due to the intelligent, vigorous, and persistent use of agricultural resources that were made to yield as they had never yielded before.

Purdue University does not know, and will never know, how much it contributed to the wartime increase in Indiana's farm production. It does know, however, that every facility it possessed was placed solidly behind Indiana farmers, that its many agricultural programs were adapted to current demands, that its activities were expanded where expansion was desirable, and that, beyond question, farming practices on a heavy majority of Indiana farms received direct benefits from its programs in education, research, and extension.

Agriculture at Purdue is under three main divisions:

1. The School of Agriculture, in which the primary responsibility is that of teaching and training.
2. The Agricultural Experiment Station, in which research is conducted on the large number of agricultural problems on which new scientific knowledge is needed.
3. The Department of Agricultural Extension, which carries to the farmers of the State the knowledge that is the basis of scientific and productive farming.

Within the three main divisions, and working with them, are thirteen specialized departments, as follows.

Agricultural Chemistry
Agricultural Economics
Agricultural Engineering
Agronomy
Animal Husbandry
Botany and Plant Pathology
Dairy Husbandry
Entomology
Forestry and Conservation
Home Economics
Horticulture
Poultry Husbandry
Veterinary Science

The three main divisions and the thirteen departments operating within them, working as a team in teaching, research, and extension, were the principal agencies by which Purdue University contributed during the war to the magnificent achievements of Indiana agriculture.

THE SCHOOL OF AGRICULTURE

The School of Agriculture recognized early that its regular four-year curriculum would be curtailed because of Selective Service, the pull of high wages in industry, and the heavy demand for labor on the farm. The School, nevertheless, had faith that, if its educational services were maintained, there would be farm youths who would be ready to use them, if not for a full undergraduate training, then for as much education as the stress of war permitted. The School also had a strong faith in the value of its training in improving the efficiency of production, processing, and distribution of agricultural products and in the stabilizing influences it could develop in the rural communities through technically trained leadership.

The School looked both at the war years and at the post-war years. Accordingly, the policy was followed that, insofar as possible, education in agriculture would remain a going business, adapted to the accelerated program and quick to make adjustments that would insure maximum use of educational services. This meant, as in other schools of the University, that a multitude of administrative problems had to be solved, that schedules had to be revised time and again, and that every staff member was expected to give, and did give, full loyalty to his new responsibilities. As a consequence, the School, though the expected decrease in enrollments did occur, kept its doors open and won a number of distinctions. For the duration, Purdue's School of Agriculture was probably the largest such school in the nation, and, so far as is known here, was the only such school to participate in the Army Specialized Training Program and the Navy V-5 and V-12 Programs.

Yet despite everything that could be done, the four-year curriculum was hit hard; and in the years to come, as in other advanced training, considerable salvage operations will be obligatory if the ideals of the School are to be reached. For the last year of the war, about 100 students were enrolled. These were men students under eighteen years of age, a few women, a small number of Navy V-12 students, a number of men not physically qualified for the Armed Forces, and a very few returned veterans. This enrollment of 100 contrasted sharply with the total enrollment of 909 in the peak year of 1939-40. In the first term after the close of the war, however, enrollment was approximately tripled, and prospects for further large increases were bright.

Throughout the war the Agricultural Winter Courses were continued, with the course work adapted to the drive for greater and greater food production. Recognition of the value of this School came from Selective Service, which ruled that a worker in a deferred status would retain his classification while he was in attendance at the School and, in some instances, required workers to attend, in the belief that a short training period during the slack season would increase their efficiency. Courses were offered in general agriculture, animal husbandry, dairy manufactures, and dairy production. A noteworthy wartime adjustment was that in the course in dairy manufactures, in which training was offered in one-week periods over a total of eight weeks, the students being enabled to receive the training that specifically fitted the needs of their jobs.

For many years short courses and conferences have been a strong point in the over-all program of the School of Agriculture. These were not neglected during the war but were continued as a vital means of training and education. Among those continued were the Annual Short Course for Veterinarians, the Agricultural Conference (with its attendance of thousands), and the Annual 4-H Club Round-Up, these being but a sampling of the work of this kind in which the School participated.

With respect to short courses and conferences, it became policy to provide special training when requests indicated a wartime need for that training. Special courses were given in the repair and conservation of tractors and other farm machinery, in farm power, in poultry husbandry, in grain grading, in the control of pests, in livestock nutrition, in rural housing, in farm-work simplification, and in other subjects in which up-to-date information was welcomed by agricultural producers. Fairly typical of the times was a conference held on a Sunday (probably the only such conference in the history of Purdue's School of Agriculture) in which plans were made for the standardization of soybean grading. Another special short course was concerned with the training of farm laborers from the southern part of the state in the ways of agriculture on central and northern Indiana farms. In the late winter and spring of 1943, more than 400 of these laborers, brought to the campus by the Farm Security Administration, were trained in fifteen one-week training periods administered in co-operation with the State Department of Education. A Pest Control Operators Conference, held in January, 1943, attracted 134 persons from 21 states, including eleven army officers, nine of them connected with the Sanitary Corps.

The instructional staff of the School was active in answering inquiries about farm problems, in delivering technical talks over both state and national radio networks, in preparing articles for newspapers and magazines, and in speaking before farm groups, school groups, and county Agricultural Alumni Associations.

THE AGRICULTURAL EXPERIMENT STATION

Agricultural research, which is the business of Purdue's Agricultural Experiment Station, is not a matter of solving a problem in a few weeks or a few months but of steady development over a period of years. A new variety of oats or tomatoes is not developed in a season. Fertilizer studies cannot be completed in a hurry and definitive conclusions reached. Problems in animal nutrition rise from one plateau to another and must be pursued at loftier and loftier altitudes. Plant and animal diseases must be conquered by the same painstaking research as the diseases of man.

For this reason, what the Experiment Station did for Indiana's wartime achievement in agriculture must be viewed principally in the light of accumulated effects. There was some direct war research—on dried eggs and dried vegetables, for example. Other research came to a head during the war years and was helpful in increasing wartime production. For the most part, however, the Station contributed by having on hand the results of years of effort and by bringing those results together to fit the critical circumstances.

In these pages only some of the high spots can be touched, and they but inadequately.

Fertilizers. Results of years of research on fertilizers were brought to bear on problems created by scarcities and the necessity of forcing top yields from the land. It was an unavoidable accompaniment of war that, when fertilizers were most badly needed, they were the hardest to obtain. Staff members counseled with government agencies to make certain that the fertilizers kept on the market were of the analyses best suited to crop production and yet conservative of raw materials. In a number of instances their advice saved fertilizers of proved worth that otherwise might have been discarded, one of them being the fertilizer of unusual analysis required for efficient use of the mucklands. Nitrogen, because of demands for munitions, was critically short. Counsel from research men on its most profitable use helped to conserve the supply and kept it available for those who needed it most.

Through Purdue research and promotion the new idea of deep fertilization with large quantities of fertilizer was introduced into the Midwest, with such success that warnings had to be issued about its limitations. The method, whatever its deficiencies if carried to extremes, during the war when yields were the chief end in view produced abundant crops from certain types of depleted soils. It gave the soils a shot in the arm, of temporary effect, which enabled the reestablishment of sound rotation practices more quickly than otherwise would have been possible and kept many acres in high production which, without deep fertilization, would have done little to add to food and feed supplies during the most critical period.

A machine developed at Purdue, since superseded, was at the time the best available for application of the fertilizer to the plough sole.

New Varieties. The classic example of how agricultural research in the development of better crop varieties paid off in increased yields is that of hybrid corn. It has been pointed out that about 99 per cent of the state's more than four and a half million acres of corn has been planted with hybrid seed largely developed and adapted to Indiana needs by research men at Purdue. During the war this meant not only the estimated 45,000,000 bushels added to corn production in each good growing season; it meant also that, in two unfavorable growing seasons when yields from open-pollinated varieties would at best have been mediocre, the adapted hybrids came to the rescue with substantial crops. Purdue was early in the development of hybrid corn, some of the first commercial crosses having been developed here.

The new Fairfield variety of wheat, the new Richland and Earlyana varieties of soybeans, and the new Clinton and Benton varieties of oats, through superior yielding ability and quality added to the feed and food supply of the nation. These were among the principal varieties of recent origin that helped build food production. Through the years, of course, there has been a steady improvement in other crop varieties. Grown on Indiana farms and appreciated because of their superiority, they helped to provide the backlog by which food production reached all-time highs. It probably should be added in passing that research men have on the way a new variety of tomato of such high vitamin A content that they have trouble in believing their results.

Muckland Crops. During World War I the Indiana mucklands were largely unused for crop production, but before the outbreak of World War II research at Purdue and elsewhere showed how these waste areas could be converted into some of the most profitable land in the state. Proper methods of fertilization, drainage, and cultivation, along with the introduction of crops especially adapted to muck soils, enabled the farmers in the muckland areas to obtain huge yields of sweet corn, onions, potatoes, celery, peppermint, and other crops—yields which not long ago had hardly appeared in men's dreams.

The muck area is one of two centers of peppermint production in the United States. After cessation of imports from Japan, the menthol derived from peppermint leaves became a critical material for use in medications. Production was pushed hard so that the utmost could be obtained from the acres available. Purdue studies of cultural practices and tests to tell when the leaves carried the greatest amount of oil gave results that were helpful in meeting the crisis. Another Purdue aid was a machine devised in the Department of Agricultural Engineering.

This machine, a sort of huge vacuum cleaner, swept up the leaves shattered from the plant and left on the ground during harvesting operations. Through its use a yield of several pounds of oil per acre was obtained that otherwise would have been entirely lost.

Dairy Products. Of the contributions of Purdue research to the wartime supply of dairy products, two stand out as having special significance. Butter had been condemned as unfit for human consumption if it failed to meet standards based on the mold mycelia count. Studies in the Dairy Department, however, disclosed that this count is not a true indicator of butter quality. Consequently, many pounds of acceptable butter were saved for the market which would have been condemned had the inaccurate standards been applied.

One member of the Dairy Department served as a trouble shooter in commercial creameries and cheese factories when a serious problem developed with regard to the destroying action of bacteriophages on starters used in cheese production. No estimate is possible of how many vats of milk were saved through this service, but it is known that the problem required a good deal of attention and expert counsel that Purdue was able and willing to supply.

Among the many training programs conducted in agriculture were a number in which small groups of workers in the dairy industry were given one or two days' instruction. These were conducted after a labor survey had shown the need for trained personnel to permit efficient operation of vital food-processing plants.

Animal Diseases. Large livestock numbers and less available help are usually accompanied with disastrous outbreaks of animal diseases. Knowledge of methods of control for the diseases, particularly hog cholera, limited their depredations so that no outbreaks of epidemic proportions cut into our food supply during the war. Because of the facts gained through research, young animals were saved which some years ago would have died. Anemia (thumps) in small pigs used to exact a high toll each year. Now the expedient of keeping the pigs on clean ground or the feeding of copper sulphate aids greatly in the control of this disease. Research in swine enteritis enabled farmers and veterinarians to control this disease more effectively than in the past. Brucellosis in swine, formerly more or less overlooked, was found to be readily transmissible to humans and to dairy cattle. Research uncovered some of the important ways in which it spreads, and field work revealed that it is possible to eradicate it from breeding herds.

Purdue services were indispensable in the development of the Indiana Clean Herd Plan for eradicating bovine brucellosis (Bang's disease). Before the war more than 8,000 brucellosis-free herds had been established in Indiana.

In swine production, as suggested in the foregoing, the most important disease threat is hog cholera. A special leaflet on control was prepared and widely distributed. All influences combined resulted in an almost 100 per cent increase in the sales of anti-hog-cholera serum in Indiana in 1942 as compared to 1941. Assistance was given in the early diagnosis of numerous outbreaks of the disease.

Feeds and Feeding. Supplement C and Supplement 5, developed at Purdue and known throughout the Corn Belt, aided in the economical raising of hogs. They put faster gains on hogs and did it with less feed than would have been required by other protein supplements simpler in nature. These supplements were the outgrowth of research that began when Purdue scientists first investigated tankage as a supplement to grain feeding. Tankage eventually became the most important protein supplement in hog feeding throughout the country and was used widely in swine research as a standard for evaluating other protein feeds.

Then followed research with soybeans, soybean oil meal, fish-meal, milk products, mixed supplements, and mineral feeds. A valuable contribution was the demonstration of the need in swine rations for mineral supplements with soybean oil meal and other vegetable protein feeds. These vegetable protein feeds, when fed with corn and other grains, helped to make possible the large war-time production of pork.

Numerous other investigations were made in the pre-war days—with pasture crops, oats, barley, and hominy feed, for example—all of them cumulative in their effect on meat production. During the war, because of insufficient supplies of protein-rich feeds, the main objective was to conserve the more efficient of them and effectively to utilize those of lower nutritive value. Efficient low-protein supplements were developed, certain low-protein rations were shown to give poor results, and the definite advantages of omitting the protein supplement from the rations of older fattening hogs on good alfalfa pasture were demonstrated. Tests were conducted to determine relative efficiency of feeding hogs to different market weights in an effort to produce a maximum amount of meat and fats with a minimum of the scarcer and more vital feeds.

With regard to the feeding of poultry, it has been maintained that, without soybean oil meal and knowledge of how to use it, the high wartime level of poultry production would have been impossible. For years animal proteins were thought essential in any poultry ration; but with the development of synthetic vitamins, research men were able to show that the vitamins in the animal proteins, not the proteins themselves, made the animal proteins "essential." With this knowledge available, research men at Purdue were able to compound rations that used the utmost of the soybean oil meal and corn and the least of the critically scarce animal protein supplements. Vitamin supplements for rations using hitherto wasted products, such as fish press water and distillers' by-products, were also devised; and this information was passed on to farmers and feed manufacturers so that the feeds available could be put to the best possible use.

When phosphorus was critically scarce, research revealed that defluorinated phosphorus, which was plentiful, was suitable for poultry rations. Subsequent investigations revealed that satisfactory broilers could be raised without any phosphorus at all.

Cumulative research pointed the way to scientific feeding of dairy cattle, both to insure more healthy calves and fewer death losses and to produce more nutritious milk. Research indicated certain minimum levels of vitamin A intake necessary for this feeding program. Associated with the research on feeds for dairy cattle was the study of vitamin A in the forage crops commonly grown in Indiana and of the methods of harvesting necessary to retain the vitamins in the forage during the feeding period.

Pastures. Research on forage crops has been of continuing interest in the Station and has yielded a volume of useful facts about such matters as drought-resistant varieties, nutritive values, and time and method of harvesting. Only a long discussion by an expert could show how much this research has aided Indiana agriculture.

Under pressure of wartime needs the role of pasture in the fattening of beef and the weights to which beef could be fattened for the most economical use of feed were investigated. It was shown that feed could be conserved if cattle were fed to lighter weights and increased amounts of pasturage were used.

Certain associations of legumes and grasses will produce larger amounts of forage than others. Intensified research on which grasses and legumes grow best together led to recommendations for the seeding of mixtures that materially increased the carrying capacity of Indiana pastures and raised the amount of forage that could be harvested from a given area.

Pasture as used in the raising of poultry was thoroughly investigated. Research men found that good pasture furnished all the vitamins and some of the protein needed to raise broilers and young chicks It also contributed to the feeding of laying hens and was important in the feeding of hens for the production of hatching eggs. Tests tried at Purdue and conducted co-operatively with farmers throughout the state greatly influenced the use of the better pasture crops for poultry. Ladino clover, a pasture crop tried decades ago, was found to have values that had gone unappreciated.

Farm-Work Simplification. In December, 1942, the Dean of the Graduate School was named Director of a national project in farm-work simplification, the general aim of which was to find ways by which farm jobs could be done more quickly and with less fatigue. Co-operating with Purdue were eleven land-grant institutions situated in areas where methods of handling a wide variety of farm products could be studied. At Purdue the jobs analyzed were related to tomato picking and peeling, hog and poultry production, and canning factory operations.

A single example will illustrate how work simplification is attained. Research workers at Purdue studied the hand-picking methods in ordinary use among tomato pickers and established rates-of-production methods. Analysis of motion pictures of a number of pickers showed that about 70 per cent of the picking time was spent in moving the hands between the hamper and the vine. Consequently, an improved method of picking was worked out to lower this, as well as the over-all time requirement. The improved method was tested in the field to establish the output that could be expected from its use. Then the rules of the method were published as a leaflet and a 400-foot motion picture was released to help teach the improved methods. The leaflet was used in several states, and a number of copies of the film were sold. In a wartime application, the leaflet was translated into German for the instruction of prisoners of war employed in the tomato harvest.

Other results have shown how much room there is for improvement in the ways of doing certain farm jobs. A study showed that, on selected farms, the work of producing hogs by the two-litter system could be done properly in about one-fourth the time required by the average farmer, and this research was reported in *Purdue Agricultural Experiment Station Bulletin No. 506.* Tabulations of the time required in poultry chores showed ranges from one and one-half to sixty minutes for one hundred hens. Results like these had a definite application during the war years when farm labor was critically scarce, and in the future will be instrumental in raising the efficiency of farm production and lightening the burden of farm work.

Moving the Food to Market. During the three and one-half years between January 1, 1942, and June 30, 1945, for-hire truckers hauled to market a volume of food products greater by far than had ever been produced in the state during any other comparable period. They did this with the trucks they had on hand, plus a few new ones. That they had the trucks, tires, and gasoline for this big hauling job was in part due to the fact-finding activities of the Agricultural Experiment Station.

The Station made six major and five minor surveys related to wartime food transportation and distributed its results through mimeographed reports. Information obtained was used extensively in counsel with ODT and OPA officials of the Indianapolis district. Plans were developed that were workable and in harmony with farmers' needs, and these were used by officials of the ODT not only throughout Indiana but rather generally in the North Central States. Data of permanent as well as transient value were obtained.

In collaboration with the North Central Regional Livestock Marketing Research Committee, attention was focused on the use of for-hire trucks in hauling livestock. Two reports on this work had wide circulation throughout the Corn Belt.

As a result of a study made of transportation problems in the dairy industry, route patterns saving of trucks, tires, gasoline, and manpower were developed.

Delivery systems at Indiana tomato canneries, uncontrolled before the war, caused delays in the unloading of trucks, some of them being tied up in waiting lines for several hours. Time was wasted, and the tomatoes tended to deteriorate because of long exposure to the hot summer sun. For one large factory, an appointment system was worked out that almost entirely eliminated this loss. It was widely adopted in the later years of the war.

Wooden containers for the packaging of fruits and vegetables were in short supply. The Station co-operated in outlining extensive experiments on water-proofed paper containers and in checking the lasting qualities of the substitute materials.

In the application of its findings on the use of trucks, the Station was greatly aided by the personal relations and confidence it had built up over a period of years. To occupy a position between a regulatory agency, such as ODT, and the folks who were to be regulated was not easy; yet it was accomplished with satisfaction and definite benefits in maintaining truck transportation of farm products and supplies.

Research on Dried Eggs. Service men who ate dried eggs during the early stages of the war were far from unanimous in their approval of the product. An industry annually producing approximately ten million pounds of dried eggs for immediate consumption was suddenly expanded to produce 400 million pounds annually for shipment all over the world and consumption as late as a year after drying. Little information was available about the effect of the drying process, packaging methods, and storage conditions on the original high nutritive value and palatability of eggs. It was not surprising that handling methods and storage conditions now known to be inadequate resulted in the opinion that dried eggs tasted samewhat like yellow chalk.

Dried eggs were of strategic importance, since their use conserved valuable shipping space. Several research agencies in the United States, including Purdue University, began studies to determine how to produce a highly palatable product with a nutritive value approaching that of the fresh egg. Later Purdue University joined other institutions in a coordinated attack on the dried-egg problem. The nerve center of this attack was the U. S. Army Quartermaster Subsistence Research Laboratory in Chicago. This coordinated approach led to many improvements in methods of drying, packing, and storing, and by the end of the war the average person was unable to detect any flavor difference between scrambled fresh shell eggs and dried eggs stored for six months at 100° F.

Purdue took the lead in research in factors affecting the vitamin A content of dried eggs. Results indicated that the drying process did not lower the vitamin A content, but that this vitamin was rapidly destroyed through storage of the eggs in open containers at high temperature. It was also demonstrated that sealing in tin cans and/or holding at temperatures below 50° F. greatly retarded vitamin A destruction.

For these studies the standard biological method for determination of vitamin A, employing albino rats as test animals, was used. This was a laborious and time-consuming procedure since more than 6,000 experimental rats were required and each assay took about two months for completion. Toward the end of the war the program was speeded up through development of a new technique for chemical determination of vitamin A content. Since several determinations can now be made per day, it is evident that the development of this technique will make a significant contribution to future research.

The method involves the separation of vitamin A and its associated pigments by adsorption on a chromatographic column. The quantity of each Vitamin A active pigment is then determined by the light absorption at the appropriate wave length, and the amount of vitamin A is determined by the light absorption after the addition of antimony trichloride. Adding the theoretical activities of each fraction gives a value closely approximating the true biological activity as determined by rat assay.

As work progressed it was increasingly evident that a major problem was the palatability of the dried eggs. The actual nutritive value of the eggs was of little importance unless they were readily consumed. Therefore, a tasting panel was established to study factors affecting palatability. The customary subjective panel methods of scoring flavor in dried eggs, in which each sample is given a score between 0 and 10, yielded unreliable flavor scores when small numbers of tasters were used. In order to study progressive flavor changes in stored dried eggs with the small number of tasters available, a new objective technique was developed that has given reliable scores.

This technique was a fundamental contribution to research on foods. Though developed for use on dried eggs, it is applicable to studies on other food substances, such as potatoes and milk, which are or can be made homogeneous. The technique employs certain new concepts in flavor-scoring methods. Strawberry ice cream coloring is used to make the samples look alike. A direct comparison is made between an unknown sample and known samples, the score being based on the taster's ability to taste rather than on his less consistent judgment.

Experimental flavor analyses were made on stored egg samples, which were prepared in commercial drying plants by the scientists of the Subsistence Research Laboratory.

For these analyses about 40,000 separate samples of scrambled eggs were tasted and judged.

As a result of these studies a number of practices have been developed that aid in maintaining palatability during high-temperature storage. Drying to a moisture content of less than one per cent at a low drying temperature, and packing in sealed tin cans in an atmosphere of 80 per cent nitrogen and 20 per cent carbon dioxide have given the best results from the standpoints both of initial palatability and of the maintenance of high palatability throughout the storage period.

Dehydrated Vegetables. Research on dried potatoes, carrots, onions, and beets was aimed at making the dried products comparable to the fresh in appearance, palatability, and nutritive value. It was begun in the summer of 1943 and had the encouragement and indirect supervision of the Quartermaster Corps, to which the results were submitted. The Purdue research was only a part of a great volume of work on dehydration conducted throughout the country; and, whatever the aversion of veterans to dried vegetables, it is probably safe to say that the quality was considerably better at the end of the war than at the beginning.

For each vegetable, research workers looked for the variety that could be dried most successfully and ran tests, before and after the vegetables were dried, on Vitamin C, carbohydrate, and mineral content. An important finding was that the Sebago variety of potato did not discolor during drying or during storage for six months at room temperature. The proof of the pudding being in the eating, dried vegetables being considered in the research were reconstituted, cooked under standardized conditions, and submitted to a taste-testing panel.

Other variables than variety were found to affect the quality of the dried vegetables, these including seasonal differences, time of harvesting, and method of drying. Potatoes of the Katahdin variety, for example, when dehydrated in 1944 were found to contain about forty per cent more vitamin C than potatoes of the same variety that had been dehydrated in the previous year. All these variables were considered in the Purdue research. Vegetables for the studies were supplied by the Northern Muck Crops Experimental Farm, where known varieties were grown under known conditions.

Growing Food Without Soil. Purdue was a major center of information on the science of nutriculture, the growing of food without soil. On remote and barren islands this science was used by the Army Air Forces for the production of healthful fresh vegetables. Purdue workers, qualified because of their long experience, helped to organize the program and to give it factual backing. Color photographs made here to illustrate nutrient deficiencies and toxicities in plants grown by nutriculture were used in the training of military personnel.

Miscellaneous Contributions. It is apparent that only a dilute scattering of the research that had a bearing on wartime agriculture has been accounted for in this report. For a complete treatment it would be necessary to go through the Station department by department showing how this project and that project gave results that were successfully applied by Indiana farmers. Nothing has been said, for instance, about research on insecticides, soil conservation, the drying of corn and hay, the introduction of parasites to control the corn borer, poultry, the feeding of hogs, and other projects of long-range importance. Some of these had their wartime effect, whether measurable or not, and others in the years ahead will give results of benefit to agriculture. The emphasis in this writing has been on that research which most directly contributed to wartime production.

In the brief paragraphs that follow other contributions are mentioned.

The Department of Agricultural Engineering, using few critical materials, developed an electric chick brooder that could be made at home for about $10. Several thousand plans for the construction of this brooder were distributed, but how many were actually constructed and used is not known.

Turf research contributed facts that helped the Army Air Forces in the development of airfields in all parts of the world, particularly in those parts where volcanic dusts were a problem in the operation of the fields.

Because they had investigated the labor requirements for the production of livestock and crops, agricultural economists were able to give good counsel to Selective Service on the establishment of fair standards for induction into military service.

Agricultural economists each summer surveyed the possible changes in the crop production pattern for the following year that would yield the quantities of commodities desired. These surveys were used in setting goals.

The common rat poison, red squill, was imported from the Mediterranean region. The supply became inferior and short. Chemists developed a method of extracting the active principle and concentrating it to make a more effective poison.

Behind the growing of hemp for Navy cordage lay Purdue research in culture and fertilization practices.

War demands for oil and feed increased the acreage of soybeans and called for additional research on their efficient production.

Because of shortages of food it became important to move supplies as rapidly as possible. With the assistance of county agents, co-operatives, and growers, a Market News Service was instituted whereby Indiana dealers were kept informed weekly, in advance, of available supplies for sale. This service was greatly appreciated by growers and handlers alike.

Research in the Department of Forestry had to do with the yield of the various lumber grades from sawlogs of different species, sizes, and qualities. Sawmills using circular head saws recovered only 78 per cent as much lumber from logs of a given size as did band mills, yet the latter sawed at a rate nearly three times as fast as that of the circular mills. Quality yields of lumber were seen to improve with an increase in log size.

THE DEPARTMENT OF AGRICULTURAL EXTENSION

For almost four decades the Department of Agricultural Extension has been taking to the farm people of Indiana the knowledge of modern farming practices that has helped to make Indiana farmers among the most progressive in the world. Through an extremely wide variety of activities extending into every county of the state, Extension has given of its services wherever and whenever they were needed and, besides contributing to Indiana agriculture in a purely technical way, has substantially encouraged the maintenance and development of a stable community life. Better farming and homemaking practices to enrich rural Indiana and the state as a whole might be said to be the general objective of Agricultural Extension.

Even before war began, Extension turned its resources to the support of the campaign to increase the nation's production of foods. In that plain statement lies a record of accomplishment which no brief summary can adequately present. Extension worked with everything from seeds to the disposal of harvested crops, from improved varieties to methods of canning, freezing, drying, and storing, from the small Victory Gardens to the farms of hundreds of acres, from the collection of milkweed pods for life-saving jackets to the planting and harvesting of Indiana's tomato crop, and from the corn detasseling camps to the efficient use of foreign and prisoner-of-war labor. How much these efforts contributed to Indiana's "impossible" production of foods, Extension is not prepared to say—it can only know that it faced and helped to solve almost every kind of wartime farm problem and that the value of its work was evidenced by the wholehearted co-operation it received among farm people and farm organizations and by the spirit in which its counsel and guidance were accepted.

Representative of the problems that Agricultural Extension faced and helped to solve were:

How to increase crop yields
How to feed and manage livestock and poultry more efficiently
How to conserve the soil and maintain fertility
How to handle the timber resources
How to produce and conserve the family food supply and provide an adequate diet
How to maintain 4-H Club work
How to meet the farm machinery situation
How to meet the labor situation

The organization that met these problems was the normal organization with added personnel to handle the heavier load. Behind Extension and contributing to it were all the departments in agriculture at Purdue University. In the field were a varying number of technically trained men and women. During the fiscal year 1944-1945 Extension was represented by 92 county agricultural agents, 15 assistant county agents, 50 home demonstration agents, 60 extension specialists, 13 administrators and supervisors, 20 Farmers' Institute speakers, and 16 men and 35 women Emergency War Food Assistants. The size of their job can be appreciated when it is remembered that there are nearly 185,000 farms in Indiana, with 813,000 people, or 24 per cent of the population, living on them. An additional 21 per cent of the Indiana population live in towns of less than 2,500 and were assisted in many ways.

Thousands of volunteer leaders assisted Extension by serving on committees, helping to plan, carrying information to others, and aiding with 4-H Clubs and other projects. Their participation, impressive enough in peacetime, increased substantially after Pearl Harbor. In 1944 the number of these leaders reached a peak at 60,630. In 1945 the number was almost as large. These figures do not represent different persons, of course, for many served as leaders of more than one project.

The Extension program consisted of the programs of the 92 counties. For each county the County Extension Committee and various project committees took the responsibility for organization and planning. These Committees, all serving without pay, consisted of men and women representing the Farm Bureau, the Granges, the home economics clubs, civic clubs, federal agencies, project committees, 4-H Clubs, rural ministers, the county council, county commissioners, and the public schools. In some counties, township delegates were appointed to the extension committees. This organization at the county level secured broad representation of the groups and individuals interested in the welfare of agriculture.

Extension's "Classrooms." Extension reached the rural people of Indiana through thousands of meetings, newspaper and magazine articles, bulletins, radio broadcasts, farm demonstrations, short courses and exhibits, farm and home visits—in short, by means of all kinds by which Indiana agriculture could be helped in its wartime task. As with the number of volunteer leaders, significant rises occurred in the wartime expansion of these activities. The number of meetings, for example, increased from 29,902 in 1941, the last peacetime year, to more than 55,000 in 1945.

Farmers' Institutes, the original form of agricultural extension, added to their record of success through more than half a century. These, as in the past, were devoted to the inspired strengthening of rural communities. Attendance was approximately 35,000 each year.

4-H Clubs continued their strong program with rural youths from ten to twenty years of age, having enrollments of approximately 50,000 annually. Members engaged in agricultural projects, such as those in poultry, hogs, beef cattle, and gardening, and in home projects, such as those in clothing, baking and food preservation. They also helped with scrap drives, bond drives, paper salvage, Red Cross campaigns, and other community projects. The 4-H Clubs were directed by county extension agents, teachers, and volunteer leaders.

Extension Schools, or Special Winter Meetings, were a vital part of the program to assist farmers in wartime food production. Instruction, given in many types of courses, included the presentation of information on farm management, crops, dairying, hogs, the corn borer, farm machinery, forestry, poultry, livestock diseases, gardens, soil conservation, and tomatoes. Extension specialists, representing different departments and loaded with the results of research in the Experiment Station, gave most of the instruction. Average annual attendance was greater than 30,000.

Through these "classrooms" and others which it would not be feasible to describe here, Extension's program helped to keep Indiana agriculture in step with wartime demands and the latest in agricultural science. Evidence of its success is found in the number of farms on which changes in practices definitely resulted. That number was greater than 100,000 each year from 1941 to 1945 inclusive and reached a peak in 1944 at 115,419.

Some Specific Contributions. Assistance in reaching the dairy goals established by the War Food Administration was given throughout the state. Emphasis was placed on proper feeding and care of the herd and the production of high quality milk. Schools taught by specialists, pasture tours, demonstration and district meetings, and managed milking demonstrations were prominent among the means used to encourage maximum production. When feeding supplies became short, Extension helped dairymen to make fullest use of the feed available and to develop planned pasture programs by which it was possible to keep cows on pasture as long as 220 days each year. Through organizations such as the Dairy Herd Improvement Associations and the Indiana State Dairy Association, dairymen were helped to eliminate the poor producers among their herds and to breed higher-producing cows.

The years of Extension work in pork production had helped Indiana farmers to adopt the practices that put hog raising on a sound, profit-paying basis. This Extension work was continued and strengthened through the war years. Working through the Hoosier Ton Litter Club, hog schools, demonstrations, and hog tours, Extension personnel aided farmers in the control of parasites and diseases, in the efficient use of feeds, and in the establishment of sound management practices. The program of full feed and clean ground, fresh water, and shade, coupled with other good management methods which Extension recommended, had its effects in the increase of pork production that Indiana farmers achieved despite shortages of labor, tires, and farm equipment. Similarly, in the production of sheep and beef cattle, Extension was instrumental in keeping Indiana farmers informed of the ways by which they could adjust their efforts to meet wartime needs and most effectively to produce the sheep and cattle even now badly needed in a hungry world. In poultry production, Extension worked on suitable substitute feeds, problems of sanitation and disease, labor-saving ideas, the adaptation of existing buildings to serve as many chicks, pullets, and hens as possible, and the breeding of a better grade of poultry to help meet the demands for eggs and meat.

As farmers have good reason for knowing, the farm labor situation became critical quickly—and stayed critical. Induction into the Armed Forces and the pull of high wages in industry reduced the number of farm workers to the smallest number in two decades—at a time when the work to be done was the heaviest in history. Extension helped to meet this problem. Then on April 29, 1943, it took added responsibility for recruiting and placing farm labor under a law passed by Congress, subsequent related laws having been passed in February and December, 1944. The ensuing program was decentralized so far as possible through the establishment of county advisory committees, and to local leaders and organizations must go much of the credit for the success achieved. For the three years 1943, 1944, and 1945, year-round placements with which Extension was concerned averaged approximately 2,000. Seasonal worker placements averaged about 55,000, and prisoner-of-war placements about 10,000. In addition, youth camps were established for such jobs as detasseling corn and picking fruit, and much work was done in assembling factual information concerning the farming operations of registrants being considered for occupational deferment.

As with other crops, Extension helped to encourage the heavier production of tomatoes requested of Indiana farmers. Both experienced and inexperienced growers attended Extension's tomato schools held in co-operation with canneries. Through U. S. "Won" Tomato Clubs, Double Tonnage Clubs, the State Tomato Show, and 4-H Tomato Clubs, Extension worked to improve both yield and quality. It also helped train green hands in the picking of tomatoes, co-operated with growers and canners in trying to obtain a level flow of tomatoes to the canning factories, and assisted with special efforts to get the necessary acreage of tomatoes contracted and planted.

In its program on home problems, Extension worked with the facts and ideas by which rural Indiana homes adapted themselves to wartime conditions. Adequate diets, the canning and freezing of foods, the care of home appliances, the remodeling of clothing, and kitchen arrangements for improved efficiency were included among the subjects studied. The means used were comparable to those by which other Extension programs were carried throughout the state — news stories, magazine articles, radio broadcasts, home economics clubs, demonstrations, and leader-training meetings.

Farm machinery and equipment meant a great deal in the times when around-the-clock work was producing bumper crops. Extension helped to keep the machinery running, cautioning farmers to order repairs early and to repair and adjust their machines during the slack winter and spring months. Machinery dealers reported that more repair parts were sold in spring months than usually were sold during the peak of the harvest season. Meetings related to this problem were attended by farmers, rural leaders, and representatives of the building-supply and lumber industries. Rural youth received training in the maintenance and care of farm tractors. Special farm-power short courses gave training to representatives of implement companies, who then gave direct assistance to farmers and farm youth. With new building construction almost at a standstill and bumper crops glutting the elevators, Extension told farmers how to convert stalls, rooms, and empty houses into grain bins. Extension also furnished plans for such new buildings as could be erected and for the home construction of chick brooders, pig brooders, tank heaters, and other time- and labor-saving equipment.

Demonstrations in many sections of the state compared for farmers the adapted varieties of hybrid and open-pollinated corn and the adapted, high-yielding, disease-resistant varieties of small grains—oats, winter barley, winter oats, wheat, and sorghums. Major new varieties certified extensively included Fairfield wheat, Tama oats, Lincoln and Earlyana soybeans, and superior corn hybrids. By thus promoting varieties developed at least in part by the Agricultural Experiment Station, Extension helped farmers to achieve yields that would not have been possible had only the older varieties been available. Farmers throughout the state were eager to take advantage of new improvements in agricultural seeds, and close co-operation between Extension and seed dealers insured the best seed supply possible. Lists of disease-resistant, adapted, and hardy varieties were furnished these dealers, who stocked them for their patrons. Co-operation in the improvement of seeds was also maintained with county crop-improvement associations, county soils and crop committees, seed producers, and the Seed Certification Service.

Fertilizer demonstrations, which had particular importance during a period of changing fertilizer analyses, gave first-hand information on the best fertilizers to use and also proved the advantages of feeding the soil to produce big yields of quality crops. Crop-production contests gave added interest and also stimulated the adoption of practices followed by the most successful growers. Among the demonstrations were a large number concerned with the new practice of plow-sole fertilization, a practice that quickly became popular and added substantially to the production from depleted soils.

The corn borer, the Hessian fly, the chinch bug, the cattle grub, and garden insects and pests all took their toll from Indiana farmers and gardeners—a toll which Extension helped to reduce by its encouragement of better farming practices and its dissemination of results from the Agricultural Experiment Station. Nearly every farmer in the important corn-growing section of Indiana received information on how to avoid corn-borer damage. Similarly, commercial orchardmen were told of improved spraying practices and better sprays for the control of orchard pests. Extension's recommendations for cleaning and disinfecting granaries and bins helped cut the loss caused by insects to stored grains; and, when war-essential materials used in insecticides and fungicides were no longer available in quantity, new control measures were tested and old recommendations revised.

Veterinary Extension assisted farmers in avoiding losses, and veterinarians in keeping informed of new techniques and procedures. At schools taught by veterinarians and Extension workers, diseases of cattle, hogs, sheep, and poultry were discussed. Subjects considered at the schools were selected by the county committees for the counties in which the schools were held.

A weed-control program sponsored by Extension explained eight general recommendations by which the prevalence of weeds was reduced. Control of such perennials as field bindweed, Johnson grass, and Canada thistle, which have been known to take over fertile fields, helped to keep needed acres in production. Emphasis was placed on the advisability of planting weed-free seed.

Extension backed special programs by which special wartime needs were met. In one of these, the growing of hemp to furnish cordage for the Navy, Extension men worked with farmers, explaining the need, helping contract acreage, advising in the preparation of the ground and seed, and giving detailed instructions concerning the handling of the crop, both when it was growing and when it was mature. In another, county agents assisted in the successful campaign to gather milkweed floss for life-preserving equipment. In a third, the production of shearling pelts for aviators' uniforms was encouraged, the total result being that the Indiana sheep industry delivered a great number of pelts for this purpose. The lambs were sheared 70 to 90 days before they were sent to market; the wool was then just long enough for aviators' uniforms.

Plant-disease projects were conducted on the control of smutted wheat, ring rot disease of potatoes, onion smut, and some of the prevalent diseases of soybeans. Resistant varieties and measures of control were explained at meetings and through publications and radio broadcasts. A specific example, illustrating the working of the disease-control program, deserves special mention. In 1941 among the carloads of wheat sold by Indiana farmers, 205 cars contained enough smutted wheat to be graded as smutted. This wheat required special handling by the mills and was discounted in price. From the grain elevators of the state, Extension workers obtained the name of every man who sold smutted wheat in 1941. Detailed instructions for the control of stinking smut were prepared and sent to each of these farmers. Of all the wheat sold in 1942, only seven cars were graded as smutted.

But to describe all the state-wide activities by which Extension supported wartime agriculture would require more pages than this volume may afford. The material in the foregoing paragraphs is only a condensation of the details related to some of the major projects and does not cover important extension work in fields not mentioned. Other activities were conducted in relation to Victory Gardens, the Indiana mucklands, commercial fruit production, farm wood lots, soil erosion and contour farming, farm organization and marketing, the keeping of farm accounts, adjustments between supply and demand, and canning crops such as corn, peas, and lima beans. All in all, Extension operated in Indiana wherever its services and the application of its technical knowledge would help to strengthen rural communities and so help Indiana farmers to achieve the increased war production that is now a matter of history.

Extension during the war helped farm folks to do more and more with less and less. Its programs, adapted and strengthened to meet the crisis, reached throughout the state and assisted in building the unity of effort by which Indiana farmers served their country through an "impossible" production of foods. In this work it co-operated with other government agencies, rural leaders, farm and civic organizations, business interests, radio, and the press, receiving help and giving help. In summation it might be said that Extension's every interest was devoted to the betterment of rural life and the introduction of the farming practices which would most effectively satisfy the wartime need.

Chapter V

CONTRIBUTIONS BY OTHER DEPARTMENTS AND DIVISIONS

IN ANY RECORD OF WAR-INDUCED ACTIVITIES, INEVITABLE omissions are bound to occur. World War II, a total war, enlisted the support of everyone, and for Purdue had its effects from the most distant of the outlying farms in Hoosierdom to the center of the campus. Throughout the conflict attempts to define war work and non-war work had no consistent success. Even the manufacturers of lipstick, it was said, had a claim on essentiality because of the grease paint they supplied for commando troops.

At Purdue it became war work when the Library acted as a war information center for the benefit of speakers who needed timely information on war topics. It was war work of a sort when the Department of Economics and History taught courses in naval history and the Department of English and Speech taught courses in Army and Navy correspondence. And surely the bustling activities in the Purdue Memorial Union represented a great extension of ordinary services, including the establishment of the Red Cross workshop in the basement, the use of the Music Room as sleeping quarters for servicemen, and the feeding of Army and Navy trainees.

Similarly, the operations of Radio Station WBAA in broadcasting for the numerous drives were classifiable as war work. The contribution of the Station was a matter of adapting ordinary services so as to inform listeners about topics of wartime importance, such as foods and rationing, the buying of war bonds, and the collecting of scrap metals.

The Department of Physical Education for Women recognized the need for increased emphasis on physical fitness and health for women students and extended its two-year required course to a three-year requirement. From the March term, 1942, to September, 1945, the Department co-operated with the Tippecanoe County Red Cross in offering courses in first aid, a total of 374 students having qualified for certificates. While the WAC School of Personnel Administration was on the campus, the Department provided recreational equipment and facilities and for each group conducted a class in recreational games, archery, and posture work.

The new Division of Technical Institutes, organized in the summer of 1943, played a part in the training of workers for war industry. It operated through three permanent centers serving the Indianapolis, the Fort Wayne, and the Calumet regions, and by the end of the war had secured about 1,300 registrations in classes largely taught by teachers drawn from industry. The training was, and is, in technical fields and is planned to give the technical worker who does not intend to go to a college or university an opportunity to make himself more valuable as a technical helper.

THE SCHOOL OF HOME ECONOMICS

The war work done in the School of Home Economics belongs in the large classification of essential services. There was no direct war research; but the School participated in the accelerated program and, with no interference from Selective Service, maintained good enrollments and a stable record of graduations. In addition, the

School responded to many calls for extra help; staff members gave generously of their time and skills in work with state and local committees having to do with adequate diets, industrial feeding, food preservation, and rationing.

Staff members taught three special courses in nutrition: a canteen course with an enrollment of 60 local women who had volunteered to direct the feeding in the community in case of disaster; a Red Cross nutrition class with an enrollment of 50; and another nutrition class with an enrollment of 90. Assistance was given to Army officers of the Fifth Service Command in securing Army dietitians and in planning courses used in their training. In this connection it is well to mention that about 80 graduates and former students served as dietitians in the Armed Forces, while an uncounted number of others, undoubtedly large, put their training to use in war plants.

Help was also given through the training of teachers for Emergency Nursery Schools in Indiana and in the running of the Nursery School Workshop held on the campus from May 27 to June 9, 1945. In the Workshop two groups of teachers received training, each group having been here for one week.

A class in home nursing attracted an enrollment of 45 local women. Practical instruction and training were given that permitted the students to do nursing duties ordinarily handled by professional nurses.

The staff of the Department of Applied Design managed the Puttering Shop for the Army and Navy Servicemen on the campus.

Staff members gave many talks on nutrition and other topics of interest in the war effort. Large numbers of letters asking for information on rationing, clothing, and similar topics were answered, and printed and stencilled material was sent to many people. The School could not train the fighters for war or do research on weapons; but it could use its knowledge of diets, foods, menus, clothing, and similar matters for the support of the civilian economy and it could train the girls needed for technical services in the war plants and elsewhere. These duties the School handled successfully.

THE SCHOOL OF PHARMACY

The School of Pharmacy has been, first of all, a teaching school, and its chief wartime responsibility was that of preparing men and women for professional services as pharmacists, laboratory workers, and technicians in civilian activities and in the Armed Forces. This responsibility it continued to meet so that the medicinal products required in normal times might be more generally and readily available in time of war. Graduates were prepared not only to dispense medicines in retail pharmacy but also to do specialized work in manufacturing and hospital pharmacy and in the development of new products and substitutes for products no longer available. As in other schools, enrollment of undergraduates declined; but a strengthened research program that grew to a size at which it crowded facilities helped to keep graduate training at a satisfactory level.

In one special wartime course, students in pharmacy and other divisions of the University, as well as men in the Navy WTS Flight Instructors School, were trained in first aid. Undergraduates trained in another course, X-Ray Technic, were in urgent demand for services in the Armed Forces. The principles of this course were taught to technicians in a special school and explained in lectures and demonstrations to other groups of technicians.

The School was prepared to offer a number of special services and found that rather heavy demands were placed upon it. Annually the School held a conference of Indiana pharmacists at which the wartime duties, activities, and problems of pharmacists were discussed. The number of prescriptions prepared in the Apothecary rose and fell with student enrollments, having reached a total of almost 80,000 in one of the busy years. From its manufacturing laboratory, in which students are trained under the direction of registered pharmacists, bulk pharmaceuticals in large amounts were supplied to the Student Health Service and other divisions of the University. Staff members served on committees concerned with pharmacy in wartime, including the War Emergency Advisory Committee of the American Association of Colleges of Pharmacy and a committee of the same name of the Indiana State Pharmaceutical Association.

The School had some success in the experimental cultivation of medicinal plants formerly imported; but this was a matter which required time and, it is not to be regretted, World War II did not last long enough for the enterprise to come to fruition.

It would not be feasible here to describe all the research conducted in the School during the war or even to list the different activities. The projects came under the general headings of (1) pharmaceutical chemistry, (2) pharmacology, and (3) pharmacy. All were conducted in the interests of public health. Some were concerned with the standardization of drug products, in war as in peacetime an important procedure, because often the standards were adopted on a state- and nation-wide basis to control the quality of preparations sold to the public.

Research on antimalarials began when it was discovered that one of the new compounds synthesized in the projects in pharmaceutical chemistry had marked antimalarial activity. An extensive program was undertaken, with help from the Purdue Research Foundation, the Department of Chemistry, and commercial and government agencies. This resulted in the preparation of many new compounds and opened up a new field in synthetic drugs. In print it was represented by the publication of "The Synthesis of Derivatives of 5-Aminoquinoline." Compounds synthesized during the research were tested for their effectiveness against other diseases as well as malaria and some were found to be active; but, with the caution and prudence characteristic of research workers in medicine, the pharmacists have reported only the bare facts of their research and have stated that in the future it may be that valuable compounds will be discovered in the new field. The research has been continued.

THE DEPARTMENT OF ENGINEERING EXTENSION

The Department of Engineering Extension carried the benefits of engineering teaching and research to persons and industries throughout the state. Like other departments of the University, it found after Pearl Harbor that many of its normal activities were of consequence in support of wartime industry and wartime training.

Through conferences, short courses, and conventions, conducted as Department activities or in co-operation with campus and off-campus agencies, the Department reached large numbers of workers and leaders in Indiana industry. Attendance declined somewhat from that of normal years because of travel restrictions, but in a fairly typical year, fiscal 1943-1944, meetings in this type of activity drew a total enrollment of almost 2800. Included among the activities were the Annual Road Schools and the Purdue Motion and Time Study Work Sessions, the first conducted through the School of Civil Engineering and the second through the Department of General Engineering.

The training of industrial foremen, begun in 1923, took on added importance when new supervisory workers were needed in the war plants. Conferences, usually held at the plant where the men were employed, were attended by from one to two thousand persons each year. Eleven different series of conferences were offered, varying in length from one to six meetings.

Fireman training, begun in 1934, was conducted through the Public Safety Institute (under which it is reported) and had much to do with civilian defense. In this connection it is well to mention a series of lectures on the characteristics and effects of demolition and incendiary bombs. These were prepared by a staff member of the School of Civil Engineering after attendance at a national training conference on aerial bombardment protection and were delivered to audiences totaling more than 1200 persons.

The teaching of mathematics and physics in the secondary schools became a matter of concern because of the need in the Armed Forces for men and women well grounded in these sciences. In November, 1942, the Department, co-operating with the Indiana State Department of Education and the Division of Education and Applied Psychology, gave assistance to secondary schools requesting it. This work consisted of conferring with teachers of mathematics and physics on course outlines and content, methods of teaching, teaching aids, etc. Talks were also given to pupils to stimulate their interest. This service was well received by administrators, teachers, and pupils and was widely disseminated over the state.

THE PUBLIC SAFETY INSTITUTE

The Public Safety Institute, established at Purdue in 1936, serves the people of Indiana in matters pertaining to the conservation and protection of human life and property. Through training, research, and special services, the Institute encourages wider use and development of scientific accident-prevention and public-safety activities. The Institute does for police and fire departments, industrial plants, schools, and other organizations what the Department of Agricultural Extension does for Indiana farm people—that is, it spreads its services throughout the state, making them available where they are wanted and needed.

Almost a year before Pearl Harbor the Institute began the program through which it made its most direct contribution to the war effort. This was in the field of industrial protection and, though related to previous activities, was an addition to the Institute's normal work. The purpose, in brief, was to provide security for war industry—to teach what the problems in protection were and to train men to handle them. It included the fire, police, and safety phases of protecting industrial personnel and property. The whole program was worked out in co-operation with such organizations as the Federal Bureau of Investigation, the U. S. Office of Civilian Defense, and the Intelligence and Security Divisions of the Army and Navy.

As a first step, the Institute held a conference with representatives of industry to determine what industry needed in protection and to outline the services the Institute was prepared to offer. As a second, the Institute undertook to assemble and interpret all possible relevant information. From over 350 sources in this country and abroad, it collected a mountain of data and from these data, as well as its own experience, it prepared a series of basic training manuals on 20 different subjects in industrial protection. These manuals, the first of their kind, were furnished to more than 300 war industries, were used by staff members as a basis for lectures and discussions, and were in wide demand both in this country and abroad.

Other publications followed, one of them a directive questionnaire consisting of more than 500 questions and suggestions, and another a monthly *Industrial Protection Bulletin,* which listed new developments in protection. In response to many requests, the Institute also compiled a directory of plant-protection personnel in Indiana.

The Institute's most strenuous efforts in plant protection, however, were expended in the training schools it conducted. The first of these was held on the campus, February 3 to 7, 1942, and was attended by 63 industrial representatives. It was followed by other campus short courses, regional short courses, and in-service courses. More than 800 persons attended the campus courses and about 2500 the regional courses. The in-service courses were conducted for the employees of 76 Indiana industries.

The Institute also provided a number of miscellaneous services in plant protection. Its staff members gave special lectures and demonstrations at industrial-guard-training schools conducted by the U. S. Army, participated in the War Department's Civilian Protection Schools at Purdue, and rendered in-service assistance to industry through personal visits and correspondence. The Institute was designated by the Governor of Indiana as the official industrial protection agency for the Indiana Defense Council.

In another kind of service, the Institute engaged in many activities associated with the wartime problems of police departments. It gave both basic and advanced war-service police training at Purdue, at regional schools, and within departments themselves. In co-operation with the Indiana Defense Council, it trained auxiliary police at regional schools. In Terre Haute, Evansville, Greencastle, and Anderson, it made traffic and engineering surveys that helped to reduce congestion and accidents. A monthly *War Service Bulletin* published by the Institute kept track of personnel losses in police forces in Indiana, and special training manuals were prepared and distributed to all police agencies of the state.

A similar program was conducted with fire departments, most of the training having been associated with civilian defense and problems of the war emergency. Included among the men trained were some thousands of auxiliary firemen, defense corps instructors, and members of industrial fire brigades. A state fire school was held each year as well as regional fire schools, and in-service training was given within a large number of Indiana fire departments. This program was run in co-operation with the Indiana Inspection Bureau and the State Fire Marshal's Department.

THE DIVISION OF EDUCATION AND APPLIED PSYCHOLOGY

On the first thought, one might conclude that the Division of Education and Applied Psychology would have only a remote connection with the war effort. Such a first thought would be wrong, however, for the opposite proved to be true. In both the training of needed manpower and in research the Division made definite and valuable contributions.

In research the Division's most direct work, with the aid of grants from the National Research Council, and the Civil Aeronautics Administration, was done in the selection and training of aircraft pilots. The studies were conducted, for the most part, with Purdue students undergoing flight training at the Purdue Airport and led to the development of several practical aids to flight training that were useful to the aviation branches of both military services. These developments included: (1) a psychological test for use in selecting aviation cadets, (2) the preparation of flight training manuals for students and flight instructors, and (3) what proved to be of considerable use in flight instructor schools, a technique for recording flight instructions in the air. In conjunction with the Armour Institute, assistance was given in the development of the magnetic wire recorder.

In other research the Division demonstrated that the word *Applied* in its title was selected advisedly, for it was active in practical matters related to the scientific selection and training of industrial workers. How much this research contributed to wartime production is one of those immeasurables for which no answer can be found. In general, the research was related to the adjustment of the worker to his job and dealt with both manual skills and the many facets of human temperament. Research reported during the war included the following six subjects of study: (1) A short mental alertness test for use in employment offices was constructed and evaluated. (2) Studies were made in job evaluation in relation to the hourly rates paid. (3) A technique for training disc-cutter operators was developed. (4) Finger dexterity scores in an ordnance plant were analyzed. (5) New methods were devised for recording operators' performance graphically.

(6) Work was done on measuring the quality of industrial supervision in the field of human relations.

The practical approach to psychological problems paid dividends in acceptance by industry of the Division's methods and findings and has led to the establishment of a number of Navy fellowships in the psychology of communication. Through these fellowships it is expected that valuable new knowledge will be developed regarding human limitations in the operation of complicated systems of instruments and in the selection and training of personnel to handle complicated instruments.

The Division's research on industrial vision uncovered facts showing how visual skills affect quality and quantity of work done by industrial employees and often, also, the susceptibility of the employees to accidents. The analysis of several thousand scores made by employees on vision tests revealed that different jobs require quite different patterns of visual skill. The analysis showed, moreover, that older employees, though they may not be adapted visually to all jobs, are frequently well adapted to some jobs and that from 20 to 40 per cent of the employees of the average industrial plant do not have the visual skills demanded by the work they are doing.

The program had industrial sponsorship, and the research men kept in constant touch with the Committee on Industrial Vision of the American Academy of Ophthalmology of the American Medical Association and a corresponding committee of the American Optometric Association. Because of the findings in the research, an Industrial Vision Institute was established at the University. It was, and is, a three-week course for industrial representatives covering the basic principles of visual skills, the methods of correlating visual-skill test scores with job performance, analysis of jobs according to visual requirements, and proper methods of identifying present or potential employees who should have a professional eye examination to insure their visual fitness for work.

Thirteen groups of persons have attended the Institute and received intensive training in the administration of visual-skill tests that are significantly related to job performance and that can be given satisfactorily by trained laymen. Articles in technical magazines have disseminated the results of the research, and industries have called upon experts from the campus to visit plants themselves and consult with those concerned with visual problems.

Besides the Industrial Vision Institute, the Division conducted other conferences and short courses, including the Industrial Training Conference, the Industrial Personnel Testing Institute, and Aeronautics for High-School Teachers, these being a part of the Division's program to give a state-wide service to industry and education. On February 24 and 25, 1944, a Juvenile Delinquency Conference was held with an attendance of 104. This was a major factor in the establishment, at a critical time, of youth centers at which young people beset by wartime's agitations and uncertainties could find a wholesome outlet for their energies.

In war training the Division worked co-operatively with the State Department of Education and the U. S. Office of Education, and engaged in so many activities that comprehensive coverage is difficult if not impossible. Possibly its first step was taken in the school year 1938-39 when a staff member made a survey in northern Indiana for the purpose of finding out what equipment the trade schools had available for training purposes. Then in July, 1940, the same staff member, covering a good deal of the state, encouraged the opening of the shops as rapidly as possible and, with the help of advisory committees, planned tentative programs of operation. Eighteen months before Pearl Harbor practically all the schools in the larger Indiana cities and in some of the smaller were running training programs for machine operators, inspectors, welders, and others.

That was only a beginning.

The Division joined in the reorganization of the National Youth Administration centers for war training and in the training of expert machinists, welders, and others to be teachers of their crafts. It helped with supervision when the vocational schools were running 24 hours a day. Before the Training within Industry program sponsored by WPB became operative in Indiana, it promoted, organized, and supervised programs to train on-the-job instructors for war plants. It participated in the training of conference leaders and conducted conferences with foremen and other management personnel. For agriculture it helped in the recruiting and training of youths and adults for food production and preservation. For the mothers engaged in war work it assisted in establishing nursery schools in war centers, and for the training of nursery school teachers it conducted special intensive courses on the campus.

Finally, staff members allocated to government agencies, as reported under Staff Activities, assumed large responsibilities in the recruitment of farm labor, vocational training, and labor relationships.

THE DIVISION OF EDUCATIONAL REFERENCE

The talents and facilities of the Division of Educational Reference proved useful to the Army and Navy in connection with their specialized training programs. The Director of the Division was appointed Director of Region Five for the so-called A-12 V-12 Qualifying Tests for Civilians, the purpose of which was to select the young men from among high-school graduates most capable of benefiting by the college training programs. In 1943-44 more than 30,000 young men, in more than a thousand schools in Indiana, Illinois, and Kentucky, took tests for which the Division had the responsibility of distribution, scoring and other processing. In the next year, when the Navy conducted no testing program, the number of candidates examined was 4,164, young men being considered for admission to ASTRP.

The Division was also responsible for the construction of some 27 tests for the AST program for which the University had a contract with the Army. These tests were constructed by various subject-matter specialists in the University in co-operation with the Division and were administered and processed here.

THE DIVISION OF PHYSICAL EDUCATION FOR MEN

Students will have no trouble remembering the course in physical preparedness that was intended to get them into condition for military service. First offered in the spring of 1941, it became compulsory with the summer term of 1942 and was continued throughout the war. Known as P.E.M. 12, and sometimes called the "torture course" by students with aching muscles, it occasioned some good-natured complaints; but surveys of the comparative performances of students before and after instruction showed marked improvement in their physical abilities. The new course necessitated the construction of a 550-yard obstacle run with 16 different types of hazards for use in training.

The Department of Mathematics reported during one of the busier terms that registrations for courses in mathematics were the highest in history. The Department of Chemistry reported the overcrowding of lockers. These conditions prevailed in the University as a whole and were matched, if not exceeded, in the Division of Physical Education. The facilities of the Fieldhouse and outdoor recreation and conditioning areas were in virtually constant use by civilians and servicemen. It was not unusual to have 35 softball games in progress at one time. Most of the men in the service groups were required to take one hour of formal physical training each day, and, during the terms when their numbers were large, the staff was hard pressed to find places to put them.

One of the most beneficial functions of the Division was to help the men who required remedial or special training. Among these were many who were classified 4-F because of minor physical handicaps but who wanted to enter some branch of the services and knew just what they had to do to make the grade. Some needed to grow a bit taller. Others needed more meat on their shoulders or to add or to lose weight. High pulse rate, high blood pressure, and lack of endurance were other causes for rejection. The Division ran special corrective programs that helped a large number of these men—possibly as many as 300—to join their friends in the Armed Forces Stretching exercises helped them to grow, work on the parallel bars improved their muscular development, and recommended diets combined with exercise programs brought their weight to the standard of acceptance. All in all, the Division had its hands full with this remedial work, enrollments having risen from a normal of about 250 to a high of about 930.

The first veterans who returned to the campus included a high proportion of casualties who were entered in the limited activities section and given special attention in accordance with the wishes of the Army. This service, directed by the Student Health Service, permitted veterans to continue treatments they had been receiving in hospitals and at the same time to further their education.

On July 1, 1943, the Board of Trustees, at the suggestion of the Athletic Institute, Incorporated, authorized the establishment within the Division of an industrial recreation section. There was no lack of activity in the program that followed. Clinics held at Purdue were well attended by industrial representatives. Other clinics and conferences in which Purdue co-operated were held at other schools. The professor of industrial recreation visited numerous cities in industrial areas for consultation and conferences on administration and research, and also prepared articles on the subject that appeared in nationally circulated trade and professional magazines. A number of research projects or studies were conducted at Purdue for the purpose of acquiring and developing information about significant problems. From the beginning the program made good progress in arousing nation-wide interest in its values and practical possibilities.

Though to some people industrial recreation may seem a frivolity, the fact is that well-planned, well-directed programs made for happier, healthier workers. There is a great difference between the worker who can relax in a recreation that attracts him and the worker who is frustrated because of the absence of suitable facilities or the lack of organizational planning. One important result observed in some industries was a reduction in the number of accidents.

THE DEPARTMENT OF GENERAL ENGINEERING

A unique contribution was made by the Department of General Engineering when its students produced parts for war machines instead of engaging in routine shop practice. Output was set up on a production basis, with students temporarily becoming workmen during the portion of each day they were in the shop, advanced students acting as inspectors, and instructors becoming foremen. Special stock material was received and Purdue was given a priority rating. Various types of industrial machinery were used for war production. This program was the only one of its sort conducted at Purdue.

The Department's shops received extraordinarily hard use when they were placed at the disposal of a program for training on the vocational level. For a time they were kept running almost 24 hours a day, if not for the full 24.

THE STUDENT HEALTH SERVICE

Though its staff was reduced by 25 per cent, the Student Health Service successfully performed numerous and varied duties over and above the routine care of the students. The extra load necessitated continuous and strenuous efforts through days that began early and ended late, sometimes in the small hours of the morning. The minimum of serious illness and loss of life on the campus during the war years owed much to this greatly increased scope of medical services.

Complete medical care was given to the following groups:

- Flying Cadets
- Navy and Marine Trainees Stationed at the University
- Members of the WAC Officer Training School
- Curtiss-Wright, RCA, and Wright Field Cadettes

Other wartime services included:

- Complete medical care, including physical examinations and records for the ROTC, ASTP, and ASTRP groups stationed at the University
- Special physical examinations for large numbers of Army Enlisted Reserve Corps and Navy V-5 and V-7 applicants
- Complete medical care for Army Personnel of the Civilian Protection Training School, as well as instruction to members of the School in first aid and treatment of burns and experimental mustard burns given for all classes
- Selective Service examinations for Tippecanoe County Board No. 2 from the time Selective Service began up to and including the present time
- Confidential medical care for chemists on government research in connection with the war

In addition to the foregoing, the Student Health Service performed much extra work with the service staff of the University because of the shortage of physicians in the community, with the athletic teams because of the increase in number of games scheduled, with students in the compulsory courses in physical education, and with entering students who arrived six times a year during the accelerated program. All this meant an added load in clerical work and record keeping, and showed the goodwill and energy with which the University in general carried its wartime load.

THE BUREAU OF INFORMATION

In all the various activities of the University devoted to the war effort, except those that were of a confidential nature, the Bureau of Information played an important role. This was especially true of those programs pertaining to food production campaigns conducted by the Department of Agricultural Extension and of the War Training Program for Industry, which sought to increase the efficiency of industrial technicians and thereby speed production of war material.

Even before the United States entered the war, the University agricultural extension forces started campaigns for increased production of milk, eggs, poultry, pork, soybeans, and certain other foodstuffs. Each of these efforts called for dissemination of news and information giving the reasons for the increases and then the facts based on scientific data for farmers to use to help achieve the food-production goals.

To help effectuate these programs, public information was badly needed. This called for complete co-operation of the press and radio, the two principal means for dissemination of the facts upon which Indiana farmers might base their own farming operations. Hundreds of news and informational stories were prepared. Extra effort was spent on garden and food conservation campaigns and other parts of the entire food programs. Special radio programs were carried throughout the war on WBAA, the University radio station, and then transcribed and sent to all Indiana radio stations and stations in Chicago, Cincinnati, Louisville, and other centers to reach Indiana farm audiences, so that farm people might know the needs for increased food production and how to attain it.

Another program of vital importance conducted by the University was the training of men and women in industry to help bring about the increased production essential to successful prosecution of the war. The Bureau of Information was called in when this project was starting. As a result of the outline of organization and promotion as worked out with those in charge, which meant wide radio and newspaper publicity, and publicity within the plants concerned, the enrollment was increased in a few weeks from about 300 to more than 7,000 and subsequently to the large numbers mentioned in the section entitled War Training for Industry. The Bureau of Information co-operated in getting this enrollment and then continued after the preliminary organizational and promotional work to publicize it in order to maintain the enrollment.

These represented the two major contributions of the Bureau of Information to the war effort, but publicity was given constantly to the various war training programs being conducted on the campus. This was done to acquaint people of the state with what was being done within an institution that belonged to them. As a result, thousands of Hoosiers shared in the inspiration and pride developed as a result of the University's work in the various activities contributing to the successful prosecution of the war.

The Bureau of Information co-operated with various staff members and many agencies in the community and over the state in helping direct, organize, and publicize War Bond sales programs, War Fund and USO campaigns, Red Cross campaigns for blood donors, clothing collection drives, and almost all phases of civilian war efforts. These tasks were performed as a service by the University to the people of the state and nation. The Director of the Bureau also served as War Fund campaign director of the county during two campaigns and as northwestern Indiana representative on the state civilian committee on Naval Officer Procurement and Army Officer Procurement; he conducted several hundred interviews of men seeking commissions in the armed services.

Chapter VI

STAFF ACTIVITIES

Staff Members in the Armed Forces

About 450 staff members entered the armed Forces. They were from practically all ranks in the University and of nearly all ranks in the services, though none achieved the equivalent of general rank. Their military experiences were as diverse as would be expected of the members of such a large group and ranged in kind from that of the man who spent most of his time on lonely Pacific islands to that of the man who earned nine battle stars.

Four staff members gave their lives: Ensign James S. Maddox, Captain Lewis L. Sisson, Lieutenant Philip Smith, and Lieutenant Wayne M. Steele. Their records appear in the Roll of Honor.

For some of the staff service men and women, entry into the Armed Forces brought a continuation, under strange conditions perhaps, of their professional careers at Purdue. While with the Navy, a biologist was assigned to the training of men for high-altitude flying, this duty being related to Purdue research in which he had engaged. A metallurgist, also in the Navy, was stationed at steel plants producing war materiel. A lecturer in the Department of History and Economics used his knowledge of the Far East while stationed in Afghanistan and later in Korea. Men from the School of Agriculture worked with the procurement and inspection of food, one of them having duty in Iran in charge of a supply area.

The Dean of Women made a distinguished record as organizer and head of the SPARS, the Women's Auxiliary of the U. S. Coast Guard. A psychologist with the Navy extended the research he had begun at Purdue on the selection and training of pilots and became responsible for the coordination of all Navy research on the selection and training of personnel and for liaison with related work being carried on under non-Navy auspices. A civil engineer became post engineer at an Army camp. A staff member of the Division of Educational Reference was a partner in the development of a highly praised gunnery trainer. The sociological arrangements of the establishment at Pearl Harbor were set up by a Purdue sociologist, who later was engaged in measuring the effect on public opinion of the steps taken to bring conquered Tokyo into line. A psychologist worked on the selection and training of men engaged in communications.

For other staff members in the Armed Forces, World War II brought the lot of hard enduring and hard sailing and hard fighting. Classroom work was no preparation for the Navy officer who participated in the invasions of Luzon, Iwo Jima, and the Ryukus; for the Navy officer in command of guns which brought down an attacking Jap plane near the Philippines; for the Navy officer whose ship participated toward the end of the war in the destruction of the Jap fleet, supply lines, and airfields; for the yeoman under fire in the invasion of Munda. Nor was University life suitable training for heavy fighting in North Africa, on the Anzio beachhead, and on the battlefields of France. Only the experience itself could supply the training for combat. In this respect the University people were like millions of others—taken from the peaceful pursuits indulged in by citizens of a "decadent democracy," they proved beyond anyone's doubt their skill in the ways of war.

STAFF MEMBERS IN CIVILIAN WAR WORK

Members of the staff as citizens of the community were expected to share in the responsibilities that all citizens faced during the war years. This meant participation in the many programs incidental to the war effort as a whole; and there is plenty of evidence to show that staff members contributed heavily of their time and energy in such activities as the USO campaigns, the OPA programs, Selective Service registrations, Civil Defense, the Victory Garden programs, War Bond drives, and the Red Cross campaigns. No attempt has been made to collect all the information about these activities. It is felt that, though the work done was extensive and important, it belonged in the great common effort of American citizens to support their country in time of war.

Mention has been made that the University, when possible, allocated staff members to do vital war work outside the University organization, either as consultants or while on leave of absence. What these staff members did, of course, reflected their professional interests at Purdue and so was of the great diversity that characterized the activities of the University as a whole. A chemist had charge of a large analytical laboratory in connection with the production of butadiene from grain alcohol. A pharmacist became head of the Botanicals Unit, Drugs and Cosmetics Section, of the War Production Board. Two members of the Department of Physical Education for Men went to Europe, one to Italy and one to Germany, to set up athletic programs for the troops. Two staff members in the Department of General Engineering worked in the aircraft industry, a third became a factory manager, and still another filled an assignment with the Bureau of Ships, Navy Department.

One of the more dramatic and direct contributions was made by a member of the Joint Highway Research Department, who, applying techniques developed within the Department, aided in effectively utilizing suitable soils after invasions in the Pacific area.

From the Department of Mathematics staff members on leave participated in a variety of research work, both in this country and abroad. One, stationed at the Radiation Laboratory, M.I.T., with three Purdue physicists, was engaged in calculations that were used in the design and development of radar components. Another organized and directed the Ballistics and Gunnery Section of the Operations Analysis Section of the Eighth Air Force. A third served in the Eighth Air Force in the analysis of the results of bombing and contributed a modification to a bombsight that greatly simplified its operational use. Other mathematicians did comparable work, which included service at the Aberdeen Proving Ground on firing tables for weapons fired from aircraft, accuracy studies in the evaluation of targets for the air war on Japan, and the theoretical analysis of the performance of a highly successful gunsight.

To add further to the diversity: a staff member from the Public Safety Institute served with the F.B.I., and a member of the Department of Modern Languages received high praise and was awarded the Bronze Star after successful fulfillment of a cloak-and-dagger assignment in North Africa for the Office of Strategic Services.

And still more: a physicist, acting as a special consultant with the Army Air Forces, helped to introduce the method of nutriculture for growing fresh vegetables at remote air bases where little or no soil was available. This method of culture (mentioned in the discussion of the Agricultural Experiment Station) was successfully used, among other places, on Ascension Island in the South Atlantic.

Several staff members in agriculture were attached to the Bureau of Plant Industry on the guayule rubber project. One was loaned to the Commodity Credit Corporation during the campaign to collect milkweed floss for life preservers. Others served in the Fruit and Vegetable Division of the War Food Administration, the Emergency War Food Administration, and the Division of Agricultural Extension of the U. S. Office of Education. A member of the Department of Forestry became Acting State Forester, assisting in the war production of timber, and another was employed as a consultant with the American Forestry Association, in charge of forestry appraisal in five states. One member of the Department of Horticulture and one of the Department of Agronomy were technical advisers to a project for growing and canning tomatoes in Cuba, a project stemming directly from the war need for food.

The Division of Education and Applied Psychology furnished at least its share of the power behind war-training programs. One member became State Director of Trade and Industrial Education. Another handled personnel work in two Indiana war plants. Others served in Washington in the vast program in which a million and a half city youths, carefully organized and sent to approved rural homes, became Victory Farm Volunteers during the most critical labor shortage. The Head of the Division served as the director of the program. Other outside contributions by members of this staff were related to the flow of labor in the grain and fruit belt, the selection and training of gunners in the Navy, and labor contracts and disputes about conditions of work.

The Head of the Division of Educational Reference was a consultant in the Adjutant General's Division, Personnel Research Section, on the construction of tests and measuring devices particularly concerned with the postwar officer-retention project. From the School of Agriculture a staff member was on leave to organize instruction in agricultural economics to members of the Armed Forces stationed in the European theater who were detailed to the Army College at Biarritz for study and instruction.

A staff member of the School of Chemical and Metallurgical Engineering was a consultant with a commercial firm on the manufacture of uranium chemicals and with another firm on the war use of a special quartz, a dollar-a-year man for the War Production Board, and an official investigator for the Office of Scientific Research and Development. Another was a consultant on the production of aluminum and once a month attended meetings of the War Production Board in Washington. A third was a consultant on the drying of foods.

To continue this incomplete but representative account of the service given by staff members acting outside the University, the following list is presented of organizations, institutions, and industries in which other staff members did war work:

Columbia University
The National Defense Research Council Staff at Harvard
The Department of State
The National Bureau of Standards

The Metallurgical Laboratory, University of Chicago
The Office of Price Administration
The Chemical Industry
The Aviation Industry
The Rubber Industry
The Steel Industry
The National Defense Research Committee
The Croft Laboratory at Harvard
The Electronics Laboratory at Harvard
The Bureau of Standards
The U. S. Navy Underwater Sound Laboratory
The American Red Cross
The Department of Commerce
The War Department
The Navy Department
The Petroleum Administration for War

Finally, it is worthy of record that the University had a leading part in the establishment of effective contractual relationships between the nation's colleges and universities and government agencies directing both war research and war training. The educational institutions wished to retain their independence of management, simplicity of operation, and ability to act quickly; and principles largely worked out at Purdue helped in the attainment of these objectives and also proved satisfactory to the Federal Government. Purdue, in a sense, became the proving ground for the procedures which were developed. Thus in the background of the Army and Navy training programs and of the scientific research conducted by educational institutions was an amount of highly skilled foundational work which, on a nation-wide basis, contributed much to the efficiency of operations.

Chapter VII

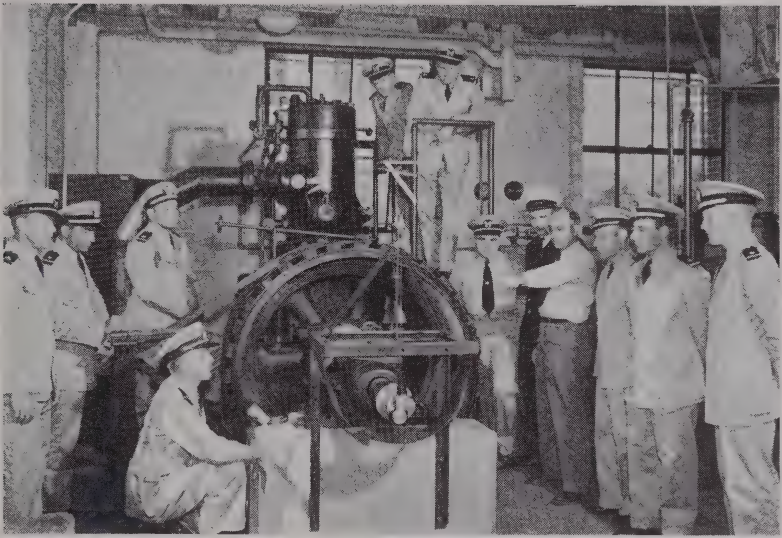
ALUMNI AND FORMER STUDENTS

ALUMNI AND FORMER STUDENTS IN THE ARMED FORCES

IN THE ALUMNI OFFICE IN THE MEMORIAL UNION Building at Purdue University are the names of 14,000 alumni and former students who served with the Armed Forces during World War II. The records, it is known, are incomplete. Other thousands during the turbulent war years at least temporarily lost touch with the University. From these facts, in accordance with established practice among alumni associations, the estimate has been made that the total number of Purdue men and women in the services was in the neighborhood of 17,500.

The full story of the contribution of these men and women can never be told. It is too big a story. Geographically it stretches from the Alma Mater to all parts of the world. Militarily it enters the many branches of the Army and Navy and is concerned especially with the Field Artillery, in which Purdue men were notable because of their numbers, their quality, and their heavy participation in combat. Tragically it includes the immeasurable and final contribution made by the more than 500 men whose names appear in the Roll of Honor.

It was at first considered that a military directory might be prepared listing the names and records of all Purdue service men and women. This idea was abandoned, however, when the size of the undertaking was defined and it



Instruction in Diesel Engineering. In the early months of the war about 200 Naval officers received training in the School of Mechanical and Aeronautical Engineering.

Lord Halifax, British Ambassador (left), and President Elliott, Slightly Sprinkled by Rain, Interviewing a Navy Student.

Motion-and-Time Study in the War Training Program for Industry. Purdue trained about 60,000 workers in college-level programs throughout most of Indiana.

A Chemistry Laboratory in the War Training Program for Industry. In more than 100 Indiana towns and cities 2,660 classes were held.

was realized that such a directory would take years to prepare and would at best be an approximation.

An appeal for information was then issued through the pages of the Purdue *Patrol,* the wartime publication through which alumni of Purdue kept in touch with one another and with the University. That appeal was a mistake, for it presumed that from the information obtained an adequate account could be prepared. Some hundreds of letters and filled-in forms were received; but, confronted with these records, the Editor in all humility realized what should have been apparent from the first—the job could not be done adequately.

There was the story of the "plank owner" of the *USS Bunker Hill,* who was on the aircraft carrier when it was struck and heavily damaged by Kamikazes near Okinawa. But to name him and say that he had three years and six months in the service, including twenty-nine months overseas, and earned eleven battle stars, would be to omit others who had similar records.

There was the story of the member of the original B-29 wing to hit Japan, who flew nine combat missions in India and China and then moved to Tinian, whence he flew twenty-three missions against the empire, winning, among other decorations, the Distinguished Flying Cross. But there were others flying B-29's including the officer who, safe at his base, was reported by the Japanese to have been shot down.

There was the story of the Lieutenant Commander, USNR, who received a special commendation from Admiral Stark for his work in planning, and participating in, the Normandy invasion.

There was the story of the T-4 with a field hospital unit who sailed to New Zealand, Australia, India, Egypt, and

England and then moved into Normandy on D-Day plus 21. He received the Bronze Star, the Good Conduct Medal, and the ETO ribbon with five battle stars while serving with an outfit that averaged over ninety points. His letter ended with the remark: "Incidentally I see by the Purdue *Patrol* that Purdue is trying to improve on powdered eggs! The best improvement I can think of is to sink all of them in the Atlantic Ocean!"

There was the story of the WAVE who was qualified to wear navigator's wings and was an instructor in celestial navigation and later a signature officer. She was one of the nearly 200 Purdue women who were in the military services.

There were the stories of the officers who served with distinction in both World War I and World War II. One of them was responsible for initiating production in four Chemical Warfare Service Arsenals and contractor's plants, the products including white phosphorus grenades, flame throwers, and gasoline jelly bombs. Another was attached to the 82nd Airborne Division and won battle stars for Normandy, the Rhineland, and the Ardennes.

A number of brief stories went like this:

> Called to active duty as a Captain in December, 1940, and was promoted to Lieutenant Colonel in March, 1944. Participated in three campaigns in the ETO and was awarded the Bronze Star.

Of such dramatic and heroic material is the record composed. To collect it all and give it meaning would take the lifetime work of a Gibbon or a Tolstoy. One man's story, if told in all its significance, would fill a volume. The stories of the 17,500 have an epic quality beyond comprehension—stories of officers and men serving in all parts of the world in all sorts of capacities—as aviators, infantrymen, battalion commanders, ordnance workers, officers and men in construction and supply, on submarine duty, aboard aircraft carriers, fighting across France and Belgium and into Germany, fighting through the island-hopping campaign north from Australia and then in the Philippines.

So much is known and yet so little is known. It is not known how many Purdue men, because of devotion to duty, competence, and heroism, were awarded decorations; but the pages of the Purdue *Patrol* and the Purdue *Alumnus* list hundreds of names of officers and men who earned the citations by which their deeds were recognized. It is not known how many Purdue men were wounded; how many were commissioned; how many served in the various theatres of war; how many were in the Navy and how many in the Army; how many were aviators and how many Marines. What is known is that, in the total war so bitterly fought and conclusively won, Purdue men and women, in service throughout the world, sailed, marched, flew, fought, and died in a war contribution beyond measure.

Since so many Purdue men had been commissioned in the Field Artillery Reserve, participation in this branch of the service was unusually heavy. General Marshall (as reported in the discussion of the Purdue ROTC) expressed unstinted appreciation of the value of the Reserve Officers. The background for his praise can be seen in the records of the men who took advanced training at Purdue. These were the officers who were called to duty early, the trained officers who formed the cadres in the camps, organized, instructed, took advanced courses, and then went overseas with the fighting units.

The Reserve Officers fought with distinction throughout the major compaigns. They were in the assaults on North

Africa, Sicily, Italy, and Normandy. They fought in the land battles in Europe and in the campaigns in the Pacific. Their battle participation was heavy and the number of decorations they won was large. Consistently they advanced in rank.

But to name some of these officers and give accounts of their records would be discriminatory against the hundreds of others who could not be named. The best that can be done is to present a few specific records impersonally, letting the few represent and symbolize the records of many.

One record is that of a member of the Class of 1926 who commanded a battalion that landed at Utah Beach in August, 1944, and saw action with the Third United States Army at Chartres and Metz, France, and Saarlautern, Trier, Gotha, and Chemnitz, Germany, and points between. This Reserve Officer was awarded the Silver Star, the Bronze Star, and the Croix de Guerre.

Another Reserve Officer wrote:

> Highlights of combat service occurred while the battalion was attached to the 4th Armored Division Artillery when we helped them exploit the Normandy breakthrough and stayed with them until they left the Lorient sector. We went over to help pulverize Brest. Another highlight occurred in the Ardennes campaign, in which we were caught in the German pincers. The Battalion won the Distinguished Unit Badge while attached to the 101st Airborne Division at Bastogne.

A Reserve Officer from the Class of 1929 served with the 104th (Timberwolf) Division, which, after 195 days of consecutive combat, joined with the Russians at the Mulde River in April, 1945. He reached the rank of Lieutenant Colonel and was awarded the Bronze Star. Other Purdue officers with the Division were a Lieutenant Colonel, two Majors, a Captain, and a Lieutenant.

A graduate of the Class of 1939 served with the First and Third Armies in Iceland, England, Ireland, France, Luxembourg, and Germany as Reconnaissance Officer, Supply Officer, Battery Commander, and Staff Officer. He entered the service as a Second Lieutenant and rose to the rank of Captain. He participated in five battles and was awarded the Bronze Star for heroic action.

A graduate of the Class of 1935 took command of an artillery battalion during the Battle of the Bulge. Of the Fifth Infantry Division to which he was attached he wrote:

> This Division was long on accomplishments but short on publicity—spearheaded the 3rd Army's XX (Ghost) Corps through France after breaking through near St. Lo; fought 800 miles in 27 days, assaulted across 26 rivers, made first "Assault Crossing" of Rhine in history, captured 86,000 Nazis, and had elements in Austria and in Czechoslovakia when the "No Further Movement" order was received on 9 May, 1945.

This Reserve Officer became a Lieutenant Colonel, served three years, three months, and ten days overseas, won the Bronze Star with Oak Leaf Cluster, and was recommended for the Soldier's Medal and the Croix de Guerre.

Excerpts from another letter from a Reserve Officer give a full story:

> I am a member of that class that was supposed to graduate in May 1943, but because of the war things were hurried up and the entire class graduated in December, 1942. While attending the University I was a member of the ROTC unit, so upon graduation I went to Ft. Sill to the Officers Candidate School. Upon receiving my commission in the artillery about ten or fifteen others from Purdue and I went to the newly activated 75th Division where I have been ever since. . . .
>
> The Division sailed for England in October and November, and I myself arrived just in time for a big Thanksgiving dinner in Wales. We sailed from England in an LST and landed in France on the 18th of December, just

> in time for the Battle of the Bulge. We received our first enemy fire on Christmas Eve, 1944.
>
> I became entitled to the Purple Heart on January 2 when I was at an observation post registering the battalion for an attack early next morning. I received a shell fragment in the hip. I am sorry but I do not have a copy of the citation for the Bronze Star, but I received it for action against the enemy for the period 24 December, 1944 to 12 April, 1945.

On the other side of the world a Reserve Officer in the Field Artillery had three Purdue graduates as officers in the unit he commanded on New Guinea. This Purdue man later participated in the attack on Munoz, in the Philippines, in a short, bitter fight that ended in the destruction of a large part of the Japanese Second Armored Division. His unit in succeeding action participated in the attack on Balette Pass, a bloody battle lasting nearly two months and ending in the opening of the pass.

And so the record goes—the record that cannot be presented completely because there is so much of it:

> Called to active duty as Captain, FA, December 1940, attended Battery Officers' Course, FAS, until March 1941. Instructor in Gunnery, FAS, March 1941 to May 1943, during which time completed the Officers' Advanced Course, the Infantry School, September—December 1942. Promoted to Major, FA, 1 February 1942. Assumed command 83rd Armored FA Bn 1 May 1943. Joined newly activated Fourth Army October 1943. Promoted to Lt. Col., FA, 20 March 1944. Left U. S. June 1944 as S-2, Artillery Section, Ninth Army. ETO Campaigns: Northern France, Rhineland, Central Europe. Awarded Bronze Star June 1945. Returned to U. S. August 1945. Returned to FAS September 1945.

In another kind of service for which Purdue men were prepared, the engineering and scientific skills on which technological warfare depended were exercised in a wide variety of ways. It was frequently said that the side that produced the better weapons and got them to the battle fronts would win. Purdue men knew what to do in that kind of warfare.

In transportation work, as would be expected, Purdue alumni performed distinctive service. To cite only three, all of the rank of Colonel, one of the Class of 1916 had a leading part in the construction of the Alaska highway and contributed richly to the effectiveness of the transport service in Iran. Another, '07, representing the Army, served as Chief of the Marine Design Board. A third, '13, had an important assignment as superintendent of all motive power, both coal and diesel, in the European War Theatre.

A Lieutenant Colonel, '22, helped supply the Air Forces with fuels, greases, oils, chemicals, and chemical warfare items. A Lieutenant in the Navy, '26, worked on the inspection and production of the Mk 1 gun director, helped rush production of T6B pontoons for the Normandy landings, and was in charge of the construction and operation of a Naval ordnance plant for producing a special chemical. Besides performing other duties, a Captain in the Ordnance Department Reserve, '38, supervised the inspection of bombs, shells, fuzes, boosters, detonators, anti-tank mines, and other materiel.

Of an Ensign, '42, it was learned only that he was on duty as an engineering specialist. A Captain in the Air Corps, '40, was Station Engineering Officer in charge of maintenance and repair of aircraft. A Lieutenant in the Air Corps, '41, test-flew experimental aircraft. A Lieutenant Commander, '27, wrote of his having had charge of the construction of a whaling base at Akutan, Alaska, of outfitting fifteen LST's with pontoon causeways and barges for the Angar invasion, and of duties as an assistant maintenance superintendent. Similarly, a Major, '13, served in a repair and utilities division office and was assistant post engineer at one Army Camp and post engineer at another.

A Major in the Air Corps, '40, reported duties that consisted of writing technical instructions, making layouts of overhaul depots, consulting with manufacturers in regard to engineering changes necessary for successful operation of engines, and attending technical committee meetings in regard to necessary tools and spare parts for maintenance of engines.

An Army Lieutenant, '38, found technical work to do in China. After receiving a direct commission in the Army Signal Corps, he took radar training at Fort Monmouth, New Jersey, and later, with a team of enlisted men, installed and repaired electrical and mechanical equipment along the Burma Road.

But these, too, are only examples showing how the men of the different classes served on technical duties throughout the world. They do not include the officers and men stationed at Oak Ridge, the women who served as dietitians, and the great numbers of others who in an inestimable variety of ways kept the war machine running.

In aviation Purdue men gave outstanding service on the world battlefronts. Mention has been made of two Purdue alumni who flew B-29's against Japan. To their contribution should be added that of an unknown number of others who flew in all sorts of planes on all sorts of missions, and of still others whose duty it was to keep the planes flying. A Purdue man who won the Distinguished Flying Cross and the Air Medal reported quietly that he had patrolled the coast of China and Formosa, that he had helped to cover the invasion of Balikpapan, and that he had a few thousand tons of sunk shipping to his credit. Another, serving with dive-bombing squadrons aboard three different aircraft carriers, received the Navy Cross with Gold Star and the Air Medal with Gold Star. A Major, '41, flying from bases in England, France, and Belgium, completed eighty-one operational missions and, among other decorations, won the Distinguished Flying Cross. A member of the Class of 1939 made it back to Italy with the help of the partisans after being shot down over Yugoslavia while on his twenty-fourth mission.

Behind these brief items plainly lies a record too vast to be encompassed by any written description. The men who flew the planes, as well as others in the services, consistently said that the only way of knowing the reality was to experience it. Included among those who served were the Flying Boilermakers, who were recruited on the campus in the early days and, upon graduation, went directly into service. Their record alone, if it could be prepared completely, would reveal a great contribution.

In the Navy Purdue men had as various experiences as in other branches of the service. A Purdue man taught metallurgy at Annapolis, helped train crews in the Atlantic, and went into action in the Pacific; besides being engineering officer on an LSM, he also acted as chaplain. A Lieutenant Commander, '40, served aboard different submarines and won a number of awards, including the Submarine Combat Pin with three stars and the Silver Star for gallantry and intrepidity in action as assistant approach officer on a submarine on war patrol. A Lieutenant (j.g.) hunted submarines in the Atlantic, was present for the initial landings at Saipan, Guam, Tinian, and Morotai, and later participated in a battle that he described as follows:

> On October 25 I was officer of the deck. We launched our daily strike of planes and everyone secured to breakfast. At this time I sighted by eye at a distance of about twelve miles the masts of four battleships, seven heavy cruisers, and nine destroyers—all Japanese. We consisted of six escort carriers, three destroyers, and four destroyer escorts. Our task unit was shelled for two hours and fifty minutes and we were the only American ship that was not hit. We lost the CVE *Gambier Bay* and also the destroyers *Johnston* and *Moel* and the destroyer escort *Roberts.* The Japs lost two cruisers and two or three destroyers . . . . I went below to the chart room to write my log. About 10.50 the ship went to General Quarters and was hit by a Jap suicide plane before the bell stopped ringing. The ship sank in about twenty-five minutes . . . .
>
> Most of us were fortunate enough to be picked up and to return to the states for thirty days' leave.

Other excerpts from letters reveal further details of the service rendered by Purdue men in the Navy:

> Much to my surprise I was assigned to the *USS Saratoga* as an engineering officer. This I found very interesting and a volume of work attached. I'll probably be with the *Saratoga* until it is decommissioned.

> The ship covered a lot of water—from Australia to Casablanca. We have spent all our time carrying passengers and planes or in qualifying pilots for both night and day landings. I have been in the construction and repair department since reporting aboard and am now first Lieutenant in charge of the department.

> I joined the Navy in August, 1944, and served on board a destroyer at Okinawa.

> The Coast Guard Temporary Reserves, as we were known, was organized mainly by yachtsmen who were too old or decrepit to get into active service. We were enrolled on a voluntary basis, without pay, but were sworn into the military organization; were furnished uniforms by the government and were under Coast Guard orders.

Of the countless human-interest stories that stemmed from the military experiences of Purdue people, one of the most fascinating is that of a husband and wife of the Classes of 1942 and 1945 respectively. The wife became a First Lieutenant in the Army Nurses Corps and acted as flight nurse on transports evacuating casualties and patients. Before she lost her log book, she recorded over eight hundred hours on the Karachi-Cairo, Cairo-Casablanca, and Casablanca-Azores routes, with several special missions into the Persian Gulf Command, South America, Europe, and Central Africa. The husband, a Captain in the Field Artillery, landed at Casablanca in December, 1942, and later participated in the hard fighting in Europe. Among his awards were the Middle Eastern Theatre of Operations Ribbon with seven battle stars, the Russian Order of Wars for the Fatherland, and the Bronze Star.

So far as is known here, the nation's highest military award, the Congressional Medal of Honor, was granted for the services of only one Purdue man, Second Lieutenant Harry J. Michael, '44, who was killed in the performance of the heroic deeds for which the award was made. A statement of his record appears in the Roll of Honor.

Of the Purdue men who attained general or flag rank, one lost his life in action—Rear Admiral H. M. Mullinnix, '15. Another, Major General Donald W. Brann, '17, died in an accident after cessation of hostilities. Their names and brief statements of their records also appear in the Roll of Honor. Listed with them is the name of Lieutenant General Leslie J. McNair, Hon. '41, who as Commandant of the Purdue ROTC from 1924 to 1928 contributed much to the strength of military training at Purdue and endeared himself to the campus and to the community.

Maj. Gen. Robert G. Breene, M. E. '17, retired in February, 1946, after service in the Army that began shortly after his graduation from Purdue when he was appointed a second lieutenant in the Engineer Reserve. He had duty in France in World War I and early in the 1920's opened a long and successful career in aviation, beginning with attendance at primary flying school and continuing throughout World War II. He mastered many difficult responsibilities and in 1943 received the Legion of Merit award for outstanding services as Chief of Staff, Second Air Force, in which capacity he served for more than a year. Promotion to brigadier general came in August, 1942, and to major general in April, 1943. From August, 1942, to July, 1944, he was Commanding General, Services of Supply, U. S. Army Air Forces in the South Pacific Area, and later was Deputy Commander for Administration, Army Air Forces in the Pacific Ocean Areas. In May, 1945, he returned to the United States for assignment to Headquarters, Army Air Forces, Washington, D. C.

Albert J. Browning, Ch. E. '22, now a vice-president of the Ford Motor Company, for more than two years served as Director of Purchases, War Department, and for almost a year as Assistant Director of Materiel, Headquarters, Army Service Forces. From April to July, 1945, he was assistant to Chief of Staff, Headquarters, Com Z, European Theater of Operations. These and other duties took him throughout the world, and exceptional performance won him the Bronze Star and the Distinguished Service Medal. He reached the rank of brigadier general in June, 1943.

Brig. Gen. J. V. Crabb, Ag. '25, soon after war's outbreak became Plans and Training Officer of the Third Bomber Command. In November, 1942, he became Commanding Officer of the 345th Medium Bombardment Group. With this group he flew to Australia in May, 1943, and immediately went to Port Moresby, New Guinea.

After six months of combat he was assigned for a short period as Chief of Staff of the Fifth Bomber Command and in late 1943 commanded the 2nd Air Task Force at Nadzab, New Guinea. In February, 1943, he was assigned to command of the Fifth Bomber Command at Nadzab, this unit then progressing up through New Guinea, the Philippines, and Okinawa and into Japan. In June, 1944, he was promoted to the rank of brigadier general. He flew approximately 150 hours of combat time, mainly in medium-altitude strafing missions in the Southwest Pacific Area, on a total of 41 combat flights.

Brig. Gen. Maurice Wiley Daniel, M. E. '31, attended Purdue for a year as a student officer specializing in automotive engineering. In World War II his assignments included periods of duty in the North African and Mediterranean Theaters of Operation as Artillery Commander and as Assistant Division Commander of the First Armored Division. For outstanding service during enemy attacks, in which he demonstrated a high order of skill and wide technical knowledge essential to close coordination between the Artillery and the Infantry, he was awarded the Distinguished Service Medal. Promotion to the rank of brigadier general came in August, 1944. In February, 1946, he reverted to his regular rank of lieutenant colonel and was promoted to the temporary rank of colonel.

Brig. Gen. Robinson E. Duff, C. E. '18, in World War I served as a captain of infantry and in World War II, in November, 1944, reached the temporary rank of brigadier general. He became Assistant Division Commander of the 10th Mountain Division and had combat service in northern Italy—in the North Appennines and the Po Valley Campaigns. After V-E Day he was redeployed to the Pacific area for the final phase of the Philippine campaign and then into Japan with the Army of Occupation. Numerous decorations accorded him included the Distinguished Service Cross, the Silver Star, the Legion of Merit, and the Purple Heart.

Brig. Gen. Frank C. McConnell, Ag. '20, entered the Regular Army in 1921 as a second lieutenant in the Coast Artillery Corps and in September, 1943, reached his temporary rank of brigadier general. In June and July, 1942, as a War Department observer he visited antiaircraft artillery units in Hawaii, Australia, New Caledonia, and New Guinea. He later was designated Chief of Staff, Headquarters Antiaircraft Command, Richmond, Virginia, and still later became Chief of Staff, Antiaircraft Command, Fort Bliss, Texas. In July, 1945, he was assigned to command the 32nd Antiaircraft Artillery Brigade in the Pacific.

Maj. Gen. Frederick L. Martin, M. E. '08, was commissioned a second lieutenant, Coast Artillery Corps, in the Regular Army, in the fall after his graduation from Purdue. He transferred to the Air Corps in 1920 and passed through various ranks to that of major general in October, 1940. In 1924 he won the Distinguished Service Medal as Commanding Officer of the U. S. Army Air Service Around-the-World Flight and in 1944 he was awarded the Legion of Merit. On December 7, 1941, he was in command of the Hawaiian Air Force and later became Commanding General of the Second Air Force. In June, 1942, he was placed in command of the Second District, Army Air Forces Technical Training Command, St. Louis, Missouri. He retired from active service on July 31, 1944.

Brig. Gen. Leland W. Miller, E. E. '18, retired in the grade of colonel in April, 1946, after an Army career that began in November, 1917, when he enlisted as a Flying Cadet in the Aviation Reserve. He attained the temporary rank of brigadier general in May, 1942. For more than a year during World War II he served as Chief of Staff of the famed Eighth Air Force and was stationed in London, England. In February, 1943, he returned to the United States and was designated Budget and Fiscal Officer, Headquarters, Army Air Forces, Washington, D. C. In this position of heavy responsibility he won the Distinguished Service Medal, having applied to his task a planning skill and breadth of understanding that made possible the successful administration of the expenditure of more than forty-two billion dollars and contributed in a notable degree to the successful administration of the Army Air Forces.

Rear Admiral Harry E. Overesch, C. E. '14, had wide service in the Pacific area and at the outbreak of war was in command of Destroyer Squadron 5. In June, 1942, he became Commandant of Midshipmen, U. S. Naval Academy, a post which he held for about a year and a half. From December 26, 1943, to March 10, 1945, he was Commanding Officer of the *USS San Francisco* during operations beginning in the Marshall Islands and continuing to Iwo Jima and the Fifth Fleet raids against Honshu and the Nansei Shoto. His awards included the Legion of Merit, the Bronze Star Medal, and a Gold Star in lieu of a second Bronze Star.

Admiral Russell Randolph Waesche, E. E. '07, Hon. '44, left Purdue after one year (1903-1904) to accept appointment to the Coast Guard Academy. His honorary degree of doctor of engineering was awarded in recognition of his "four decades of loyal and distinguished service to the nation during war and peace." Throughout

World War II to December 31, 1945, the date of his retirement, Admiral Waesche served as Commandant of the U. S. Coast Guard and directed the greatest expansion in its history, from a peacetime organization of approximately 15,000 to a wartime force of more than 170,000 officers and men. During the course of the war he toured both the Pacific and European war zones in prosecution of the operations of the Coast Guard forces and gained for the Coast Guard recognition as a strong, efficient, and valorous branch of the Armed Forces. His leadership and ability in these and other achievements earned him the award of the Distinguished Service Medal.

What is plain, however, was stated at the beginning of this section—the military achievements of the 17,500 Purdue men and women in the Armed Forces were too vast to be presented in a brief historical account. Not by showing a few records, not by telling of the officers in the Field Artillery and of the officers and men in other branches of the services, not by giving the names and records of the officers who reached the highest rank, can this war service be described. Fully to present the record would require fighting the war battle by battle, for Purdue men and women were everywhere. The private fought as hard as the general; his contribution—all he had—was as great. The aviators, so many of whose names appear in the Roll of Honor, themselves created an historic epic. And other epics were created by others, on such a scale that comprehension is truly impossible and fitting description beyond the scope of man's power.

ALUMNI AND FORMER STUDENTS IN CIVILIAN WAR WORK

There is no way of showing adequately but briefly the contribution of civilian alumni and former students. A few achievements can be cited. Some attempt can be made to show representative details. A list of activities in which Purdue men and women engaged can be presented. But it may as well be admitted now that the account is foredoomed to failure. There is too much evidence for a summation. Purdue people in all the ramifications of industry, in agriculture, in service with government agencies, and in an unknown number of other fields made too large a contribution for coverage in anything smaller than a thick volume.

Purdue University has about 22,000 living graduates and a still greater number of former students who took some part of the training and education it offers. Civilians among these not only rose to high place; they served in lesser ways without public acclaim, helping to provide the substance included in the nation's war potential. To tell what all these members of the Purdue Family did would be like accounting for the sands of the sea. The best that can be done is to show what some of them did and to let their service represent the service of others—and to admit frankly that the job is too big to be handled.

Among the enterprises in which alumni and former students engaged were those in the list that follows:

Supervision of optical designing, tool development, and maintenance of production quality of Army automotive lamps
Investigation of claims for the U. S. Engineers
Metallurgical work in plants producing B-29 engines
Development of processing for cartridge-case steel
Introduction of a method of making cheddar cheese from pasteurized milk in Midwestern and Southern states
Chemical research in the food industry
Design of optics for fire-control instruments for the Army and the Navy
Testing of penicillin
Testing of fighter engines

Production of small electrical airplane instruments
Supervision of inspection of machine guns and aircraft barrels
Research for the Army Air Forces
Production of synthetic resins for the Army and the Navy
Manufacture of accessories for Navy combat vessels
Supervision of testing on LST's
Direction of ordnance project manufacturing 105-mm howitzers
Plant production surveys, material inspection, and procurement
Testing of toxic gases, incendiaries, and smokes
Aeronautical engine and jet propulsion work
Responsibility for administration of wartime pricing and related problems affecting 30,000 baking establishments
Development and production of the proximity fuse
Production of beryllium copper parts for a wide range of war equipment
Production of reels for combat wire, blitz cans, ammunition boxes, and fire extinguishers
Responsibility for development of production goals for crops, livestock, and livestock products
Participation in war production for which four Army-Navy E awards were made
Electrical design for military installations
Construction of vessels for the U. S. Navy and the British Admiralty
Direction and coordination of research on fruit and vegetable dehydration
Development and improvement of facilities for radio-teletypewriter operation
Planning and construction of naval air and fleet bases
Design of motor graders to level landing fields during construction and repair after bombing
Designing of diesel engines
Research, development, and production related to tentage, bulletseal fuel tanks, and synthetic rubber
Research and development of radar circuits

But these items, impressive as they are, hardly begin to scratch the surface. They indicate the contribution of scores when the contribution was made by thousands. If any generalization can be made about them, it is that in technical work Purdue men and women had more responsibilities than anyone ought to attempt to classify or to evaluate.

Someone proposed that if anyone wanted to know who had contributed, he should be shown a copy of the *Alumni Directory*. The proposal makes good sense. Add to the *Directory* a study of the columns of the Purdue *Patrol* and the Purdue *Alumnus*, and the letters and cards which have come to the Alumni Office, and one will obtain at least a faint comprehension of a vast and inclusive service that produced weapons, food, ammunition, ships, airplanes, tanks—and the list could be continued indefinitely.

Here is the record of a young alumnus who arrived at Oak Ridge when there were only half a dozen dormitories and a partially constructed cafeteria in the townsite and who, in rush development work, performed vital duties in engineering, maintenance, and procurement. Here is the record of an alumnus who supervised the shell production of a large ordnance district and was cited for meritorious civilian service. Here is the record of another, on the staff of the War Production Board, who handled priority applications in several fields for the entire nation. Here is the record of a manufacturer whose plant shipped more than 100 million pieces after May, 1940, some of them so small that 200 thousand could be contained in a coffee cup. Here is the record of a Purdue man who had large responsibilities in the construction of hangars and floating dry-docks.

But the foregoing records represent the contribution of only a few Purdue people. They may not be typical of thousands, but it is surely accurate to say that they are typical of scores and probably accurate to say that they are typical of hundreds.

Purdue alumni led in the planning and directing of the Training Within Industry Programs that resulted in almost 2,000,000 certifications for supervisors in over 16,000 war production plants and essential services—programs that saved money, time, and labor. Many alumni were prominent in research, among them a graduate who brought into production a device that greatly improved the effectiveness of American tanks, and another who worked quietly but brilliantly in the development of jet propulsion. A Purdue alumnus served as President of the American Society of Mechanical Engineers during the most critical year of the war. Another led in the direction of the Engineering-Science-Management War Training programs.

There were many others whose work would be specifically cited in a longer account, among them the leaders in transportation, a field in which Purdue has been dominant for half a century, the research directors, plant managers, the civilians attached to the Armed Forces who aided in the construction of a wide variety of installations and the development and production of weapons and ammunition, the directors of food programs, the leaders in agriculture.

Of all the Purdue Alumni and former students who served with distinction in civilian war work—and it must be remembered that there were many whose contribution has not even been indicated—the names of two stand out—those of Claude R. Wickard, '15, and William L. Batt, '07. Claude Wickard, Secretary of Agriculture for most of the war period and creator of the inspiring slogan "Food will win the war and write the peace," sparked vital food production and conservation programs. William Batt, for his services in Washington, particularly with the War Production Board, received deservedly high acclaim. His courage and insight in integrating war production, in setting the wheels of industry turning in the right direction and in keeping them turning, brought him assignments to one important task after another.

In summation, if a summation were possible, it might be said that, turn where one will, he will find that the men and women of Purdue did what was expected of them. The nation needed factories—Purdue men helped to build them. It needed ordnance plants—the engineers who for years have left the Purdue campus to enter industry were not found wanting in their design, construction, and operation. It needed the supervisory skill to direct the production by which miracles were achieved — Purdue men contributed. It needed new knowledge gained through research—Purdue men and women helped to staff the laboratories. It needed leadership—the record needs no further amplification. Technical war, depending for its outcome not only on the courage and sacrifice of millions but in getting superior weapons to the world battlefronts in quantity and on time, was not made for these Purdue people any more than it was made for the Purdue men and women in uniform; but it was a war that they knew how to support, and support it they did, through a contribution of almost endless variety and immeasurable significance.

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